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THE SUSQUEHANNA RIVER BASIN
A PLAN FOR CLEAN WATER
VOLUME 1

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
WASHINGTON, D.C.

1969

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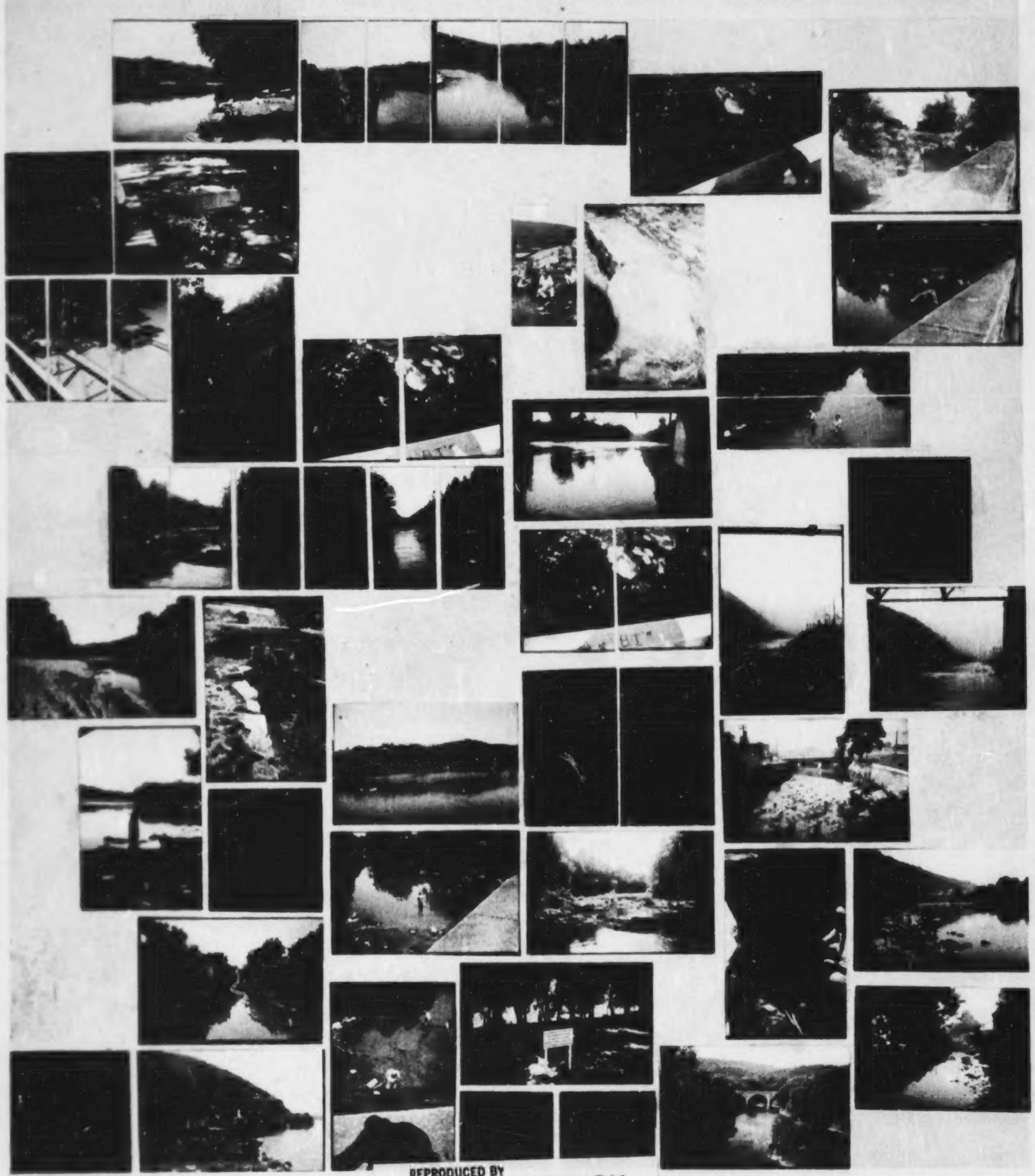
SUSQUEHANNA

A PLAN FOR CLEAN WATER



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In this volume the Susquehanna River Basin, which borders on New York, Pennsylvania, and Maryland, is described and problems of water quality are discussed. Pollution surveys directed principally to mine drainage and organic waste discharge are discussed. Stream flows need to assimilate projected waste loads are calculated and water supply needs are identified. Details relating to the Chemung sub-basin and the upper Susquehanna sub-basin are included.

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THE SUSQUEHANNA RIVER BASIN:

A PLAN FOR CLEAN WATER

Federal Water Pollution Control Administration
Department of the Interior

Howard W. Miller, Director, Susquehanna Field Station
Robert S. Davis, Technical Publications Writer-Editor

1969

The FWPCA extends gratitude to the many state, local, private, and federal agencies who have aided in this study.

STATE AGENCIES

- Pennsylvania State Health Department
- New York State Health Department
- Maryland State Health Department
- Pennsylvania Department of Forests and Waters
- New York State Conservation Department
- Maryland State Planning Department
- Maryland Department of Water Resources
- Pennsylvania Bureau of Mines and Mineral Industries

FEDERAL AGENCIES

- Army Corps of Engineers
- Soil Conservation Service
- Geological Survey
- Bureau of Sport Fisheries and Wildlife
- Bureau of Outdoor Recreation
- Bureau of Mines

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FOREWORD

The Susquehanna River Basin from source to mouth is historically well known for its beauty and **tranquility.** Since the early days of American history, people have come to live there to enjoy the surroundings and to follow their life's work. Coal mining and associated activities developed soon after the turn of the 19th century and this led to precipitation of the industrial revolution and urban development in the basin. But now, a hundred and fifty years later, hundreds of miles of streams are virtually devoid of aquatic life because of mine drainage and the often vile combination of municipal and industrial wastes discharged to them. Municipalities and industries have tended to permit gross trash and untreated organic pollution to be deposited in the streams, excusing their actions on the basis that mine drainage has already destroyed them. These pollution conditions have been building since colonial times and the continued industrial expansion coupled with urban growth keep constant pressure on the streams.

The condition is not beyond recall. This study, begun in 1961, recommends a course of action designed to reduce specific amounts of pollution and to completely eliminate others. It reflects the desires of the basin's populace by basing recommendations on the water quality standards adopted by the states of New York, Pennsylvania, and Maryland and approved by the Secretary of the Department of the Interior.

Benefits will be counted in terms of recreation, fish production, and swimming. In many places these activities are not enjoyed; but when the programs described here are realized, the people will once again use the Susquehanna and enjoy to the fullest its wealth of life's amenities.

Furthermore, as these benefits are met through the program for clean waters, the improved quality will also provide better water for municipal, industrial and agricultural uses.

Water quality and supply problems in the Susquehanna River Basin are recognized are primarily public responsibilities. Nearly all levels of government within the basin have some function dealing with the construction and maintenance of waste treatment and collection or water treatment and distribution facilities or the enforcement of water quality standards and health laws.

State agencies also control many aspects of water supply for protecting public health and providing sewage treatment facilities. The states exercise the authority through granting permits for constructing facilities, by setting minimum health standards, and by legislating financial arrangements.

The Federal Water Pollution Control Administration supports state action in pollution control with grants for program administration, watershed abatement planning, and treatment plant construction. It becomes directly involved where an enforcement action becomes necessary on interstate streams. Other federal agencies which play a role in pollution abatement are the Corps of Engineers, the Soil Conservation Service, and the Bureau of Mines. The U.S. Geological Survey supports water quality studies and surveillance activities with data collection efforts.

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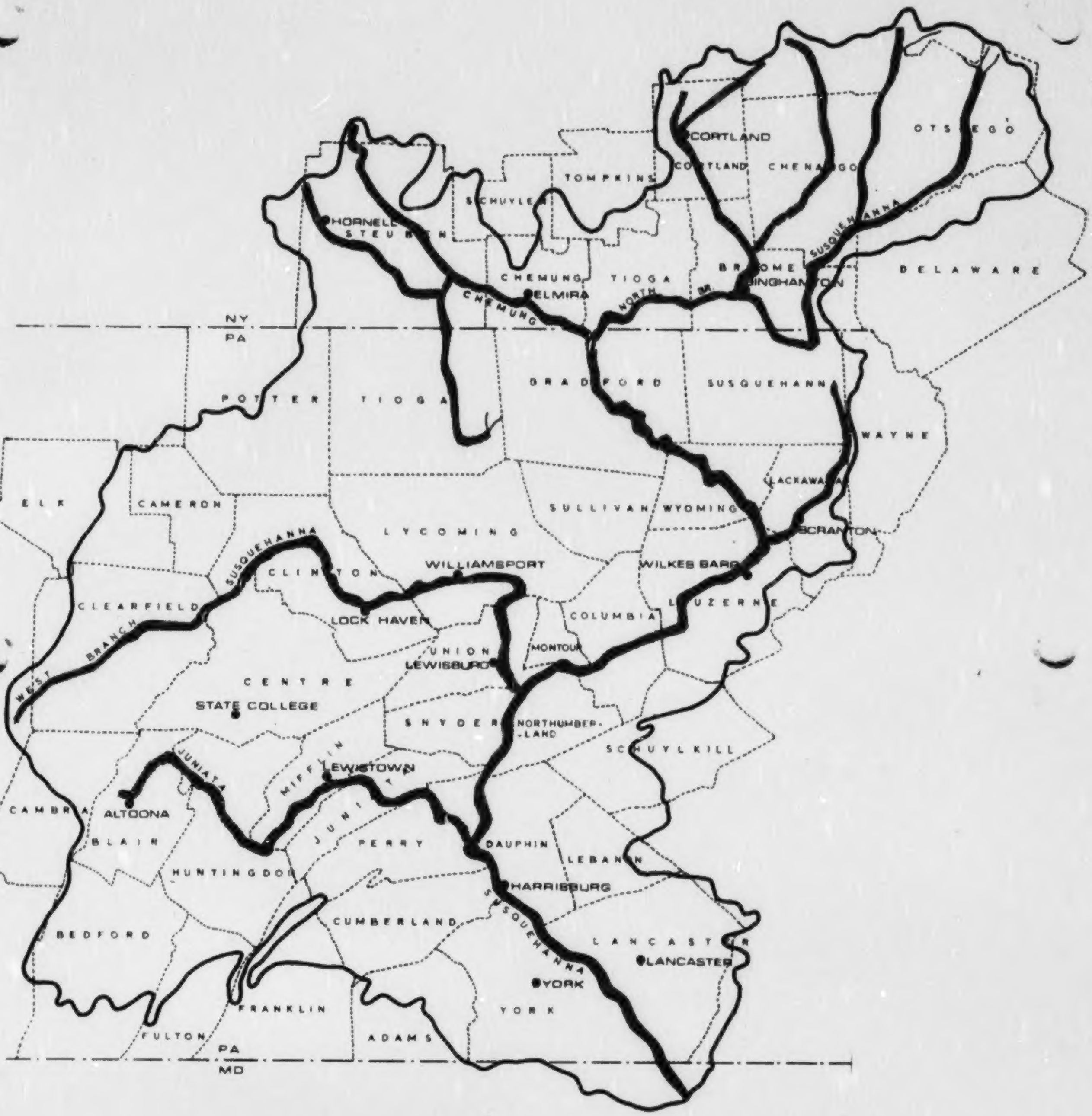
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LANCASTER
BEDFORD
YORK
YORK
FRANKLIN
FULTON
ADAMS
PA
MD

INTRODUCTION

General Conduct of Study

The study was conducted through a balanced combination of pollution surveys and calculations of stream response, review of published reports on findings of the related studies, and coordination of all findings with state and local officials. The latter was intended to reflect the local knowledge of needs, problems, and desires.

The National Planning Association, under contract with the Federal Water Pollution Control Administration and with financial support from the Baltimore District Corps of Engineers, made a study to provide economic and demographic information useful to water resource planning for the Chesapeake Bay-Susquehanna River Basins.

Pollution surveys were directed principally to the two major water quality problems of the basin, i.e., mine drainage and organic waste discharges. A sizeable portion of the sampling and analysis was devoted to mine drainage, with considerable time and effort spent in locating discharges and determining the chemical and biological effects on receiving streams. Also, there was much effort devoted to developing cost estimating procedures, abatement measures, and a priority system to choose among the most important areas to concentrate mine drainage abatement efforts. A separate report described in detail the mine drainage problem and its solution.* Biological, physical, and chemical investigations were conducted, and related to streamflows, temperature, and upstream waste loadings to determine the extent of organic pollution.

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* Mine Drainage in the Susquehanna River Basin, Mid-Atlantic Region, FWPCA, Department of the Interior, 1969, Charlottesville, Virginia

In 1965 and 1966, seven task groups were established, with membership comprising representatives from local, state, and federal agencies. The information developed by these task groups was useful in establishing water quality standards and in arriving at water supply needs and waste projections. The regional health engineers who cooperated in this early task group effort are the ones immediately responsible for the clean streams programs of their respective areas; their opinions and knowledge regarding the practicality of the recommendations in this report were highly valued.

Waste treatment needs were calculated for the basin by dividing it into 130 sewage service areas. These areas surround population centers producing at the waste equivalent of 5000 people or more and are the nuclei around which future expansion of sewage service facilities will likely occur. The waste assimilative capacities of receiving streams was tested with the assumption that each sewage service area would discharge at a single point. It would be possible to use these sewage service areas as the nucleus for regional collection and treatment developments; this would be an important first step in a regional solution to providing clean streams.

The boundaries of these sewage service areas generally conform to those of an existing water service area. Water service, population, industrial growth, and waste production are related in a positive way; and as the demand for water increases, accompanied by an increase in the size of the supply service, the demand for waste collection and treatment also increases. In many instances, these sewage service areas consist of two or more existing sewage districts with two or more treatment plants.

The stream flows needed to assimilate the projected waste loads while maintaining an average D.O. (dissolved oxygen) of 5.0 mg/l were determined by using a computerized simulation model* of the oxygen sag equation. This formulation mathematically relates the physical and biological interaction affecting dissolved oxygen in a flowing stream. Stream flow deficiencies were determined by comparing the flow needed to meet the D.O. objective with the mean monthly flow which occurs once-in-20-years. Domestic waste loadings were estimated on the basis of an ultimate BOD loading of 0.25 lb/person.

To determine water supply needs, about 88 concentrated water service areas were identified and used to predict future demand for water. Water service areas are defined as a centralized water distribution system serving a demand equal to at least 5000 people. It is usually an area encompassed by minor political boundaries and can be an urban or suburban community, a rural residential area, or a commercial-industrial complex. These will likely serve as nuclei around which future water needs will develop and do not necessarily follow existing water distribution authorities.

* * *

The first half of the report describes the basin and discusses the problems of water quality in a general way. In the second half, details have been organized into six sub-basin sections: Chemung, Upper Susquehanna, West Branch, Middle Susquehanna, Juniata, and Lower Susquehanna, and special needs, problems, and solutions within each are described.

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* Worley, J.L., A systems analysis method for water quality management by flow augmentation in a complex basin. Master's Thesis, Oregon State University, 1963.

Interagency Activities and Legal Authority

While this study was being carried out, the FWPCA participated in the Susquehanna River Basin Study Coordinating Committee. The committee report, due out in 1970, is a broad spectrum study involving all the uses of water as well as related land resource uses. It also enlarges on flood [illegible] measures, reservoir construction, power production, recreation, agricultural uses, etc. that have certain water quality requirements and a great impact on the regional development and environmental quality in general. The FWPCA is participating by preparing the appendix dealing with water quality needs throughout the basin and by chairing the sub-committee on mine drainage abatement needs. Much of the data prepared for this report will be shared with the coordinating committee study.

This interagency effort is commonly referred to as a Type II Study and was authorized by the Senate Public Works Committee in 1961. The FWPCA Study, called a 3(a) Study, was also undertaken in 1961. It fulfills the obligation under Section 3(a) of the Federal Water Pollution Control Act of 1956 and addressed itself to water quality improvement and maintenance.

Interstate Compact

The Susquehanna River Basin Compact has been passed by the legislatures of the three states through which the river flows. It is designed to set up an intergovernmental commission to develop water resources of the basin and to counteract any water pollution that develops. It is also designed to give the Federal Government equal power and responsibility for the commission's activities.

Bills have been introduced into the 1969 Session of Congress for the inactment of legislation to establish the compect. The Department of the Interior is in the process of reviewing the legislative proposals.

SUMMARY

The Susquehanna Basin, with a drainage area of about 27,500 square miles, begins in lower New York State and ends in Maryland at the head of the Chesapeake Bay. Portions of three states are included in the basin: New York, Pennsylvania, and Maryland. All three have developed water quality standards for interstate streams which have been approved by the Department of the Interior. New York and Maryland have established standards on virtually all streams of their states which lie within the Susquehanna Basin. Pennsylvania has established standards on all interstate and many intrastate streams.

The basin is characterized by rolling mountains in the northern portion which is the headwater portion, rugged mountains in the central, and rolling hills and limestone valleys in the southern portion. Over 60 percent of the basin is forested, with the remaining surface covered by grassland and farms, disturbed by mining or developed as urban centers.

In 1964, there were about 3.4 million residents in the basin with about 2.25 million or 70 percent living in urban centers served by public water supply systems. It is estimated that by 2020, the population of the basin will have grown to 9.5 million. The primary areas of economic growth are projected to occur around Binghamton and Elmira, New York, and Lancaster, Harrisburg, York, State College, and the Wilkes-Barre--Scranton area in Pennsylvania.

All types of recreation uses are made of the waterways of the basin and this is expected to be an ever increasing demand on the resource. Use of the Susquehanna for all types of recreation, including fishing, is a little less than 37 million user-days per year. By 2020, recreation use will increase to over 203 million days per year with an estimated 23 million annual fishing days, assuming no restrictions due to water quality.

All residents of the basin rely on the Susquehanna's abundant supplies of water for municipal and industrial use. In 1965, about 1.1 million residents utilized individual ground water systems, while 2.3 million residents relied on municipal systems. The municipal systems supplied an average of 600 million gallons per day.

The cities of Chester, Pennsylvania, and Baltimore, Maryland, both outside the basin, are using 80 million gallons of Susquehanna water per day to satisfy municipal and industrial needs. Although there are other diversions, these are the most significant. About a third of this is diverted via Chester to Delaware River drainage, and the other two-thirds to the Chesapeake Bay by way of Baltimore. By 2020, an estimated three million residents outside the basin will be dependent on it for more than 800 million gallons per day of municipal-industrial supplies.

The municipal-industrial use of water within the basin will increase to 2.5 billion gallons per day. There will be extensive reuse, which emphasizes the importance of high sewage treatment levels at discharge points. Furthermore, 35 percent of municipal-industrial water needs met by the Susquehanna are tapped from the last 50 miles of river and tributaries. This will increase to about 56 percent (1.4 billion) by 2020.

In the entire basin during 1965, 16,000 acres of agricultural land were irrigated, using water at an estimated peak rate of 191 cfs (cubic feet per second) from surface water supplies and five cfs from ground water supplies. It is estimated that by 1985, 48,000 acres will be irrigated, using water at a peak rate of 527 cfs from surface supplies and 52 cfs from ground supplies.

Mine drainage and organic pollution, separately and in combination, limit recreational use of the waterways and make it difficult to project future usage. The West Branch, for example, is subjected to restricted use due to both mine drainage and organic pollution. Mine drainage abatement is necessary to provide opportunity for desired water uses. In the lower Susquehanna, aquatic life is suppressed by heated discharges. In the remainder of the basin, body contact recreation is not condoned where either organic wastes or mine drainage is significant. About 21,000 acres of water are restricted by mine drainage and about 22,000 acres are endangered by excessive organic and nutrient wastes and heated discharges.

Organic wastes are discharged into the river and its tributaries from about 130 sewage service areas totaling a population equivalence of more than 3.5 million. Altogether, 310 miles of tributaries and 120 miles of principal rivers are degraded by organic wastes.

About 1.8 million people are served by sanitary sewers; 360,000 are served by systems that discharge untreated waste to streams; systems serving about 870,000 people discharge waste to streams after primary treatment; and 542,000 people are served by systems that discharge after secondary.

There are more than 150 federal installations in the basin. Forty-one produce more than 1,000 gallons per day of waste, but 24 of these discharge to municipal waste treatment systems. Seventeen installations have individual systems.

There is a nutrient pollution problem in the basin, and associated algal blooms are a recurring condition in late summer through many reaches of the main stem and some tributaries. Data indicate that most of the phosphorus and nitrogen is contributed by sewage effluents. Agricultural runoff also contributes significant quantities of phosphate in the intensively farmed country of the lower Susquehanna. Background concentrations of phosphates originating from cultivated land range from 0.3 to 1.0 mg/l. Algal growths from nutrient pollution are most severe in Spring Creek of the West Branch, Raystown Branch of the Juniata, Chenango River and the Susquehanna below Endicott of the Upper Susquehanna, and numerous small streams of the Lower Susquehanna.

The effects of sediment on quality seem to vary with farming practices as well as with soil types. Sediment appears to be a problem on the same watersheds where background phosphate loadings are high, or where land cultivation is **the most extensive.**

Mine drainage pollution is extremely serious in the basin. About 297 square miles have been disturbed by mining operations and tributaries originating in these areas contribute about 1.8 million pounds of acid per day. Mine drainage severely degrades over 800 miles of tributary streams and principal rivers. Also, 1720 acres of impounded waters are or will be seriously degraded.

The section of the basin where most of the mine drainge pollution problems exist will soon be exposed to east-west traffic utilizing Interstate Route 80, placing the area within a three-hour drive from New York City. Much of the recreational demand projected for the Middle Susquehanna and West Branch areas is expected to come from this traffic. **Streams** of high quality in these areas will come under increasing pressure for recreation and the need to abate acid pollution to make useful **streams out** of these now severely degraded will become even more imperative.

In 1968, there were 12 fossil-fueled and two atomic-powered electric generating stations in the basin generating an average of 4000 megawatts of electricity and in the process using approximately 5800 cfs of river flow for cooling purposes. In addition, there are four significant hydro-electric dams capable of generating 870 megawatts when river flows below Harrisburg exceed 85,000 cfs. One pumped storage facility is capable of producing 800 megawatts.

By 1985, it is predicted that fossil-fueled, thermal generating capacity will increase to 4290 megawatts; however, heated water discharges will decline to 3400 cfs of water for cooling, which is an indication of the greater reliance on closed cooling systems to meet water quality standards. During this period, five nuclear-thermal stations will be built, having a combined generating capacity of about 4500 megawatts. Hydro-electric facilities will be increased to 1100 megawatts of maximum generating capacity and pumped storage capacity will increase to 1800 megawatts. The thermal pollution potential is serious in the Susquehanna below Harrisburg and all new installations should be equipped with forced cooling systems.

All of these water quality problems reflect the extent of use and reuse of the waters of the basin. In many cases it is already known what steps or studies should be undertaken to curtail water pollution at the source. Details are described in later sections of the report; the most important conclusions and recommendations are briefly discussed in the following few pages.

CONCLUSIONS AND RECOMMENDATIONS

Municipal and Industrial Wastes

There are 130 principal waste service areas which discharge concentrated organic wastes to streams in the Susquehanna River Basin, including 110 municipal and 20 industrial discharges. Thirty-two waste service areas discharge untreated sewage, 46 have only primary treatment, and 52 have secondary facilities. To service projected 1980 populations, an estimated expenditure of about one billion dollars will be required. About 600 million of this will be required for expanded sewer lines and about 400 million will be used for new and improved treatment facilities.

Recommendations: (a) Provide secondary treatment for the 78 sewage service areas that presently do not have it. Eleven of these areas discharge to acid impregnated streams and the need for more than primary treatment on these could be deferred until mine drainage abatement is in effect. (See Immediate Needs, Sub-basin sections.) (b) Provide nutrient removal as well as high level BOD removal for 22 sewage service areas. In seven of these, flow regulation can be considered as a supplement to otherwise adequate secondary treatment.

Combined Sewers

Forty-two sewage service areas have systems that mix storm runoff with municipal wastes. These 42 areas provide sanitary sewerage service to about 54 percent of the basin's population. As a result, as much as 1,973,000 population equivalents could be subject to by-pass around treatment plants during storms; by 2020 this figure could reach a total of

8,942,000 population equivalents, if the problem is not resolved. Inefficient waste disposal practices have tended to mask the effects of combined sewers.

Recommendations: Studies should be undertaken in both New York and Pennsylvania to gather details on the problem so that a set of corrective actions and priorities can be developed. As communities complete new treatment systems, intensive studies should be undertaken to evaluate the effects of storm water and combined sewer discharges and formulate necessary corrective measures.

Communities should not extend the total length of existing combined sewers and federal grants will not ordinarily be made for constructing such facilities.

Sedimentation

Sediment-discharge measurements by the Department of the Interior's Geologic Survey indicate that about three million tons of suspended sediment are carried annually by the river. The highest loads occur in watersheds with anthracite mining activity in the middle Susquehanna area and in the intensively farmed lower Susquehanna area.

According to the Department of Agriculture, soil erosion is the predominant problem on nearly 3.2 million acres of the 4.2 million devoted to crops.

Recommendations: Land treatment is feasible and necessary for the protection and improvement of nearly 3.2 million acres. Land treatment measures for controlling sedimentation that should be undertaken are stripcropping, diversion terraces, and grassland management and improvement (through modern fertilizing methods and planting with newly developed, vigorous varieties).

The entire basin is now sub-divided into soil conservation districts, and the control of sedimentation should be furthered by farmers and land owners if they will avail themselves of the technical and financial help proffered by the Federal Government for constructing soil erosion control structures.

Sedimentation arising from urban and highway developments can best be controlled at the source. It is recommended that enforceable state or local ordinances be passed to halt this kind of pollution.

Nutrients

Nutrient loads occur throughout the basin and are associated primarily with the effluents from municipal and industrial waste collection and treatment systems. In nearly every case, the nutrient load is evidenced by algal and weed growths during the summer months when water temperatures are high and stream flows are low. Stretches of streams where nutrients are suspected to be in solution but not evidenced by algal blooms or aquatic weed growths are usually reaches suffering from excessively low pH as a result of mine drainage pollution. Presently, very little is known on how to control nutrient pollution effectively at low cost.

Recommendations: Some degree of nitrogen and phosphate reduction should be required at all significant sources of nutrient production. Studies should be undertaken to assess the costs and to establish priorities among the sewer service areas that may require this kind of treatment. The degree of removal required should reflect the current and anticipated extent of the problem downstream. A separate report on the data concerning nutrients is in preparation, which will describe the present conditions on nutrients throughout the basin.

An evaluation should be made of nutrient loadings leaving the Susquehanna and entering Chesapeake Bay. For the Susquehanna Flats, too little is known at the present time about the interrelationships among nutrients, oxygen, and population shifts within ecosystems to make concrete statements on exactly what should be done to alleviate the nutrient loads. Studies are needed to expose and define these interrelationships. Associated studies are also needed to determine the oxygen needs to maintain a desirable ecosystem in the Flats.

Thermal Pollution

Potentially the most serious thermal pollution problems are in the lower Susquehanna sub-basin below the Brunner Island and Peach Bottom power stations. The reaeration and assimilative capacity of the lower river has been decreased because of four hydro-electric dams that by themselves cause a tendency towards warmer water. In Safe Harbor and Conowingo Lakes, the assimilative capacity is projected to be critical if organic loads from the new Lancaster treatment plant grow as anticipated. Thermal discharges in the future from Three Mile Island, Brunner Island, and Peach Bottom will have a detrimental effect on dissolved oxygen in Safe Harbor and Conowingo pools unless properly controlled. Attainment and maintenance of water quality will depend upon controlling thermal discharge and organic loadings.

Recommendations: A mix of alternatives is recommended to protect water quality. These involve modified forced cooling systems at the power plants, high level BOD removal for the municipalities discharging effluents to the lower river, and flow regulation.

The power facilities are Metropolitan Edison's Three Mile Island Plant, Pennsylvania Power and Light Company's Brunner Island facility, and Philadelphia Electric's Peach Bottom Plant. The direct organic waste loadings come from Middletown, York Haven, International Paper Company (at York Haven), Columbia, and the new plant (below Columbia) that serves Lancaster.

Mine Drainage Abatement

There are about 620 miles of tributaries and 230 miles of principal rivers seriously degraded by mine drainage originating in 27 watersheds. A cost for total abatement of this problem was estimated on data collected from small areas that were studied in detail.* Measures providing most significant abatement are strip mine reclamation, mine sealing, stream channel paving, and surface water diversions. Lime neutralization of the remaining acid flows will be used after these measures have been installed. The estimated total cost is 226 million dollars, of which 40 percent is for preventive measures and 60 percent for collection and treatment facilities. Average annual expenditures for a total program of complete mine drainage abatement totals 35 million, of which 15 million would go for annual operation and maintenance of the various types of facilities.

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* Gannett, Fleming, Corddry, and Carpenter, Inc., "Acid Mine Drainage Abatement Measures for Selected Areas within the Susquehanna River Basin," Contract No. WA 66-21, U.S. Department of the Interior, Federal Water Pollution Control Administration, 1968.

A program to abate the mine drainage in the 12 watersheds where the results would be most beneficial will cost 85 million dollars in capital expenditures and 11 million annually. Of this annual cost, seven million would be for operation and maintenance.

> Recommendation: Mine drainage abatement should begin on the 12 watersheds recommended by the Mine Drainage Work Group, part of the effort by the Coordinating Committee for the Corps of Engineer's Susquehanna River Basin Water Resource Study discussed in Waste Sources, Problems, and Abatement of Pollution. This Work Group also recommended a priority schedule among these 12 watersheds. To effectively abate mine drainage problems in each watershed, the type of mining conducted should be assessed first so that the optimum mix between preventive and treatment measures can be realized. After the program for each watershed is undertaken, downstream water quality should be continually monitored to assure maximum benefits are achieved.

Federal Installations

Nearly all of the federal installations in this basin have complied with federal Executive Order No. 11288. This order calls for all federally owned or operated activities to provide for secondary treatment or its equivalent or to connect with a municipal sewage treatment facility providing adequate treatment. Six installations require remedial actions to control waste discharges, and all six have taken steps to comply with Executive Order No. 11288 and to meet applicable water quality standards.

Recommendations:

(1) Construction of sewage treatment plants is planned at the Allenwood Federal Penitentiary and at the New Cumberland Army Depot. The FWPCA concurs with the need for constructing waste treatment facilities at these installations, and the installations should proceed with their plans.

(2) Connection with the local municipal collection and treatment facility is feasible and should be completed, when it becomes available, for the Property Management and Disposal Service Depot in Binghamton, New York. The sanitary wastes of the Lewisburg Federal Penitentiary, now being treated by a secondary plant on the premises, should also be connected to the municipal system.

(3) It is recommended that the Lewisburg Federal Penitentiary also look into the possibility of pretreating their industrial waste and then discharging it to the local municipal treatment facility.

(4) The Veteran's Administration Center in Bath, New York, has completed a study on the feasibility of connecting to the municipal treatment system. The matter is now under consideration by the Washington Office of the Veteran's Administration. If connection

is not feasible, the installation should begin immediate action to plan for its own secondary treatment plant.

(5) The Scranton Army Ammunition Plant should proceed with its plans for a cooling tower to handle treated wastes. The domestic wastes, boiler blowdown, and process water already go to the Scranton city sewer, and plans to do the same with other industrial wastes should be considered.

Agricultural Wastes

Runoff from agricultural land causes nutrient loadings in some localities of the basin. The problem may be aggravated by dairy farms where the animals are pastured near streams, by feed-lot operations and barn washings.

Recommendation: Where too little is known about nutrient pollution, localized studies are required throughout the basin to ascertain both the kind and amount of nutrients as well as their sources.

Concurrent with the studies, information should be gathered to inform local authorities on the kinds of treatment systems that are available and suitable to their particular problems.

In specific places, such as State College in the West Branch, nutrient removal is already a fact. Methods should be investigated for controlling nutrients contained in agricultural runoff from the extensively farmed areas of the lower sub-basin.

Protecting High Quality Streams

As measured by dissolved oxygen and biological activity, there is high quality water in 870 miles of tributaries and 450 miles of principal rivers. Included are three reaches of the Susquehanna:

Cooperstown to Binghamton in New York, Sayre to Pittston in Pennsylvania, and Sunbury to the Chesapeake Bay.

Recommendation: Land use planning should be coordinated with water quality standards so that these streams are maintained in their present state of high quality. The anti-degradation policies of New York and Pennsylvania should be vigorously pursued.

Pollution Surveillance

The states have initiated and are expanding their surveillance programs.

Recommendation: These programs should be constantly reviewed and revised to the advantage of the latest surveillance and analysis methods and computerized information storage and retrieval systems. It is also necessary to expand surveillance on stream quality to include specific places where urban and rural runoff may cause water quality problems. Streams should be monitored for toxic materials, nutrients, and conventional water quality parameters.

Operation and Maintenance of Waste Treatment Plants

Inefficient operation or even complete failure of sewage treatment plants are often the causes of unnecessarily heavy loads of BOD from municipalities throughout the basin. Treatment plant failures are often caused by lack of knowledge on basic principles and neglect.

Recommendations: Certification for waste treatment plant operators should be granted only after the prospective operation has been thoroughly grounded in the scientific principles of the treatment process, many training programs are already available to meet these needs. Refresher courses in operation and maintenance should be required from time to time to keep the operators up to date on the latest methods of running their particular system. These can be items in the state or federal program or provided by the manufacturer of the treatment system.

Treatment systems in towns situated above river reaches designed for the highest uses of water should be operated only by qualified personnel. These plants, furthermore, should be equipped with adequate safeguards to prevent any accidental spill over. The design of sewage treatment systems should include failsafe devices such as overload sewers and auxiliary power sources to guard against pump failure.

Individual and Regional Treatment Systems

About 1.4 million people in the basin are served by individual sewage disposal systems. Despite the trend toward community systems and regional treatment, it is projected that by 2020 there will still be 1.6 million people using individual systems. Septic tank disposal can be very effective in preventing stream pollution, but efficiency depends on soil type, size of drain field, and proper maintenance and cleaning. With proper design, installations, operation and maintenance, septic systems will operate successfully. Pennsylvania and New York have begun programs to make recommendations based on soil conditions and lot sizes likely to provide for successful septic tank operations.

Recommendations: The states in this basin should encourage schools, homes, and factories in outlying areas to use properly designed and installed septic tanks and drainage fields or associated methods of waste disposal. The programs in all three states for planning and regulating on-lot systems should be strengthened to encourage more effective and efficient on-site systems in areas where it is necessary to use them.

Package treatment has in the past become widely used by small communities for economic reasons. Although these plants have low cost, the operation is critical because they require frequent maintenance to maintain top efficiency. It is recommended that package treatment plants be installed only where it is impossible to connect with regional treatment or to install a septic system with a drain field. In places where package treatment is used, the state should require daily maintenance followed up by frequent and regular inspection of the package treatment system by the responsible authorities.

Connection with regional treatment facilities is recommended in all cases. Where this is not possible, septic systems are recommended depending upon soil conditions and land available for suitable drain fields.

Irrigation

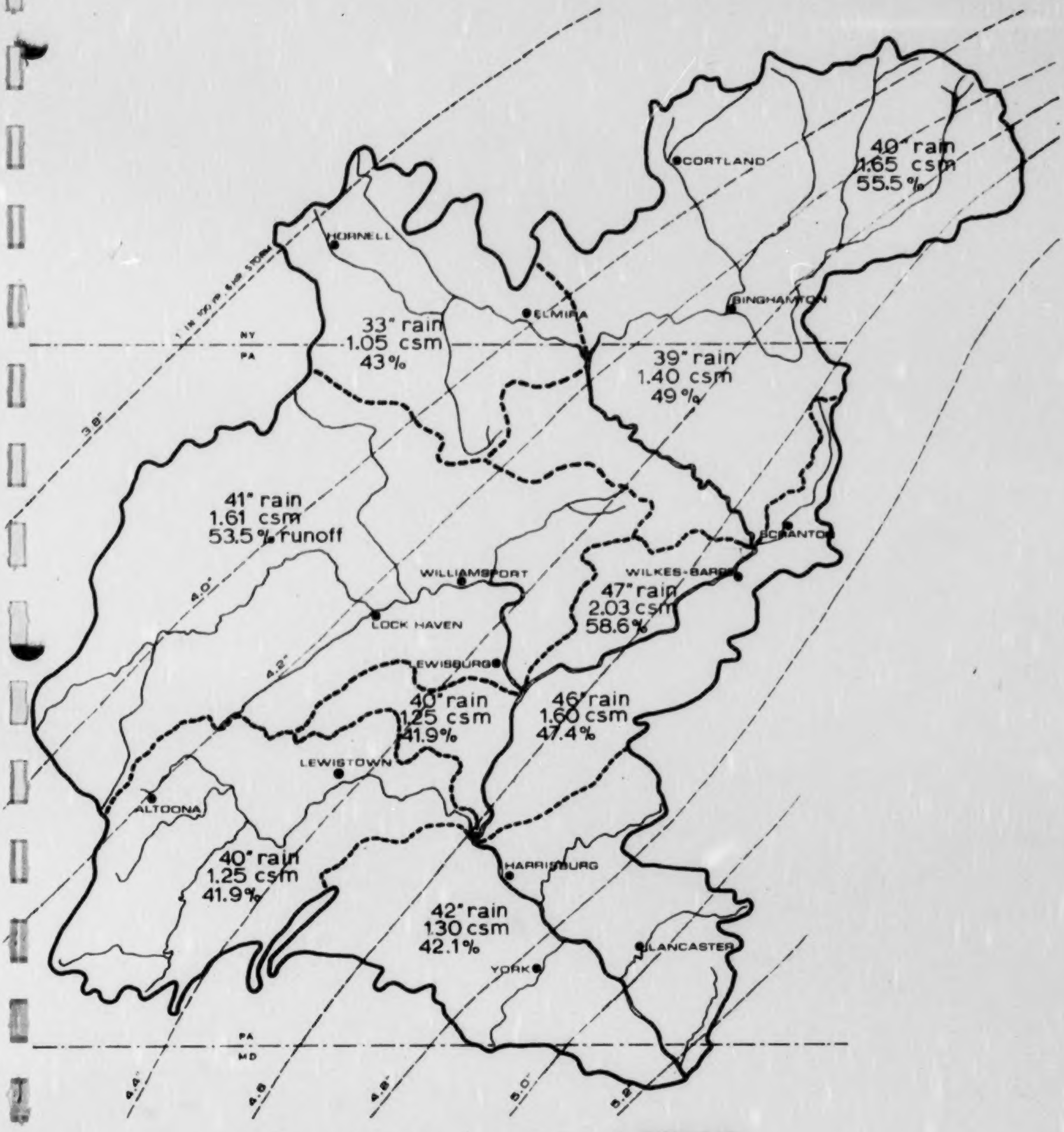
Use of water from irrigation is projected to grow from 16,000 acres irrigated in 1965 to 48,000 in 1980. While in most reaches this will not significantly tax surface water resources, irrigation use will directly compete with water quality flow needs in the following reaches:

Upper Susquehanna in Binghamton area
Chemung River below Elmira

Conestoga Creek in Lancaster area
Conodoguinet Creek in Carlisle area
Conewago Creek below Hanover

Recommendation: Where irrigation demands compete directly with water quality or water supply needs, reservoirs should be constructed to provide added surface supplies for all uses. Otherwise, irrigators should be required to use ground water rather than stream flow during emergency periods.

Modifications of state doctrine determining rights to use surface water will be needed in the near future to provide an equitable basis for meeting all beneficial water uses.



LEGEND

cu ft./sec/sq mi.(rate of water yield).....csm

percent of runoff..............................47.4%

average annual rainfall..........................33"

The Susquehanna River Basin drains about 27,500 square miles of area, beginning at Lake Otsego, New York, 75 miles northeast of Binghamton, and ending at Havre de Grace, Maryland, at the head of the Chesapeake Bay. Its principal tributaries are the Chemung, West Branch, Juniata, and Lackawanna. It is one of the most productive rivers of the East with an average annual yield of about 36,000 cubic feet per second.

Topographically, the Susquehanna is characterized by rolling, patternless mountains in the north; by rugged mountains in its middle portions; and low, rolling hills and wide limestone valleys in the south. Elevation varies from a few feet above sea level at Havre de Grace to 2600 feet in the mountains south of Great Bend, New York, and west of Altoona in Pennsylvania.

The climate is temperate with four sharply defined seasons. Mean temperatures vary from 46 F in the northern mountains to 52 F near Chesapeake Bay. Average annual predipitation is fairly well distributed throughout the year, varying from 30 to 47 inches with about 20 percent of the precipitation occurring as snow.

Over 60 percent of the basin is forested, with much of the remainder covered by grasslands or disturbed by mining. Throughout much of the West Branch drainage area, as well as the streams in the anthracite coal regions, the streams are degraded by mine drainage. The lower portions of the basin are intensively farmed for such crops as corn, tobacco, and tomatoes.

The mid-1960's population stood at 3.4 million residents with two and a quarter million living in urban centers that have municipal water supplies. Much of the basin has a history of slow or negative growth rates. Exceptions to this are found in the lower portion around Lancaster, Harrisburg, and York and in the Binghamton area of the upper basin. Population projected to 9.5 million by 2020, of which is expected that 7.5 million will be living in urban centers.

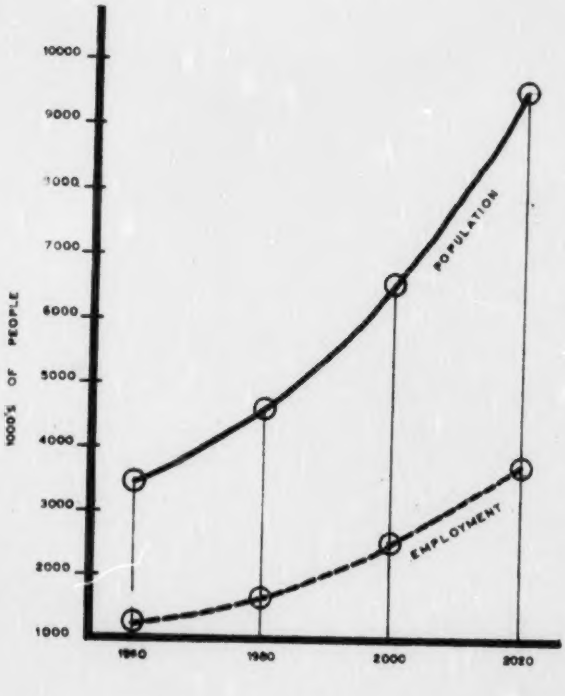
Water Resource Base

The basin has 4622 miles of trout streams; 73,540 acres of streams and rivers capable of supporting balanced warm water ecosystems. In addition, there are about 36,000 usable acres of lake surface exclusive of water supply reservoirs.

The quantity of water for most demands is adequate to meet the needs, but low flows occur occasionally that interfere with municipal and industrial uses and recreation. For example, in August the average flow is 12,200 cfs at Conowingo Dam, but the flow can be expected to reach a low of 3500 cfs once every 20 years. The critical months, as expected, are in the late summer when high water temperatures depress oxygen concentration.

Month	Average Flow cfs*	1-in-20-yr. Low Flow cfs
January	38,800	8,600
February	39,300	12,700
March	77,400	36,200
April	72,400	39,800
May	46,300	16,000
June	25,700	8,600
July	15,500	5,300
August	12,200	3,500
September	11,300	3,050
October	16,900	2,820
November	25,800	4,520
December	32,500	6,660

* Flows estimated at Conowingo, Maryland, projected from Marietta, Pennsylvania, stream gage.


projected population trends

Economic Base

The basic framework for the economic analysis was a major economic base study completed by the NPA (National Planning Association), Washington, D.C. The basic theory was a shift-share model that had been used to analyze historical periods. The NPA took this historical analysis technique and turned it into a model that projected employments for three decades. This study is in basic agreement with other studies of the area with the exception of one major point. Due to the sharp decline of the birth rate since 1962, the recent studies are using the Series C Census of Population Fertility Schedule versus using the Series B Schedule of the Bureau of the Census. This has a tendency to lower the population projections from approximately 1.6 to 1.3 percent annually. However, few studies are as detailed in analysis as the NPA study in providing for small area projections.

The economic region encompassed by the Susquehanna River Basin includes ten New York counties bordering the northeastern part of Pennsylvania and 33 of Pennsylvania's 67 counties. Economic data and projections for several counties outside of the hydrologic area are included primarily because of their close economic relationship with counties in the hydrologic area.*

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* For this discussion, the population totals are greater than for the hydrologic base. This is because economic and political boundaries were used here rather than geographic or hydrologic ones. As a result of this, the population total is greater than the sum of the six sub-basins as described geographically and this holds for the industrial data as well.

The population within the region grew very slowly during the 1950-1960 decade because of a substantial net outmigration throughout the basin of people in the 20-34 age group. However, population is projected to increase at the rate of about 1.7 percent annually over the interval 1960-2020. Total civilian employment only increased by about one percent, manufacturing employment expanded about six percent, and population increased by about five percent. Total population is expected to increase from 3.5 million persons in 1960 to 5.5 million in 1990 and 9.5 million in 2020. New immigration is expected to contribute to a growth rate which will exceed the Nation's.* The Harrisburg-York-Lancaster area experienced fairly brisk growth during the decade and served as a safety valve by absorbing some of the migrants from other subregions within the basin.

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* Employment data for the Nation is on a person-count basis while in the basin and subregions it is on a job-count basis. Because of dual "job holding," the basin employment ratio is by definition higher than the Nation. (See Summary Economic Base Study Chesapeake Bay Drainage Basins, Bibliography, Item No. 1.)

Growth in employment is projected at two percent per annum over the 60-year interval, increasing from 1.2 million in 1960 to over two million in 1990 and to about four million in 2020. This growth rate exceeds the Nation's, partly due to an anticipated increase in the rate of employment for females.

Employment in industries that market their goods outside the basin declined from 55 percent of total employment in 1950 to 50 percent by 1960, and is expected to decline still further to 35 percent by 1990. The precipitous decline in mining and agricultural employment, accompanied by a slow expansion in manufacturing employment, resulted in slow regional growth and locally severe and persistent unemployment.

Agricultural employment represents a smaller percentage of total civilian employment within the basin than it does for the Nation; in 1960, it comprised about six percent of the total and about nine percent nationwide. The absolute decline in agricultural employment is projected to continue in the region into 1985 and to begin to increase thereafter. Nonetheless, it will continue to decline as a percent of total civilian employment, decreasing to about 3.5 percent in 1990 and two percent in 2020. The area is a major producing region of milk, livestock products, and food crops; it is these commodities that will account for most of the farm labor needs.

Employment in mining represents, and will continue to represent, a larger percent of total employment within the basin than for the Nation as a whole. Employment in this sector is projected to continue to decline in importance, decreasing from about two percent in 1960 to 0.5 percent of total employment in 2020. A precipitous decline in mining employment, resulting in a loss of more than 40,000 jobs between 1950 and 1960, had a severely depressing effect upon the economic performance of the basin. The areas in Pennsylvania surrounding the Luzerne, Lackawanna, and Northumberland County anthracite fields and the bituminous fields in the western portion of the basin experienced serious adjustment problems.

The percent of the labor force in government employment within the basin is relatively low in relation to the rest of the Nation, accounting for about five percent of 1960 employment in the basin and about eight percent for the Nation. This is primarily attributable to the fact that there is a very little Federal Government employment in the area. Basin employment in this sector is projected to more than triple during the interval 1960-2020, primarily because of the expansion of employment by local governments; however, similar growth will take place at the national level. The proportion of the region's jobs in the government sector, however, will continue to be much smaller than for the Nation as a whole.

Increased levels of real income and leisure, as well as improved transportation networks should cause residents and non-residents to increase their demand for the basin's recreational resources. It is expected that employment in the recreation-roeinted industries will triple by 1990 as a result of this impetus.

Within the manufacturing sector, employment in 1960 was about equally divided between durables and non-durables, although the durables are projected to account for about 60 percent of the 1990 manufacturing employment. The major water using and consuming industries of food, textiles, pulp and paper, chemicals, petroleum, and primary metals accounted for about 25 percent of manufacturing employment within the Susquehanna Basin in 1960. Employment in textiles is projected to decline significantly and to increase by about 10,000 in food and paper. Chemicals and primary metals will remain virtually unchanged. Employment in the petroleum products sector is not significant in the aggregate. The net impact of these divergent trends will be for employment to decline modestly in the water using industries.

Percentage of Employment by Industry

Year	Agriculture	Mining	Construction	Manufacturing	Government	Large Water Users
1960	6.2	1.8	3.9	35.9	4.9	9.0
1980	3.9	0.8	5.5	28.2	4.9	6.7
2000	2.9	0.7	6.8	21.2	5.8	*
2020	2.2	0.5	7.4	15.7	6.7	*

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* The NPA study made no separate projections past the year 1990 for the large water using industries. (See Bibliography, Item No. 1.)

In spite of the stability of the level of employment, the major water using industries will continue to be important within the Susquehanna Basin because of increases in output per worker. For example, in the textile industry the gain in output per employee will be significant enough for total output to expand while employment declines.

The following table gives the percent change in total output from 1960 to 1990 for the large water using industries.

Projected Growth in Output for Major Water Using Industries
(in percent)

	1960 to 1970	1960 to 1980	1960 to 1990
Food	62	146	276
Textiles	24	21	33
Paper	69	152	209
Chemicals	119	297	581
Petroleum	240	780	1206
Primary Metals	32	81	154

The importance of these industries will vary among the six subregions. Chemicals and pulp and paper will be very significant in the Upper Susquehanna, and food, textiles, and chemicals in the Middle Susquehanna. All the water using industries will be important in the Lower Susquehanna with primary metals important in the West Branch and pulp and paper in the Juniata.[1]

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[1] The significance of the industries is based upon an analysis of a given subregion's share of projected employment and output in the respective water using industries, on one hand, and its share of total basin employment and population, on the other.

Despite the forecast that the textile industry will experience a drastic contraction by 1990 within the basin, textiles will continue to play an important role in the Middle and Lower Susquehanna subregions.

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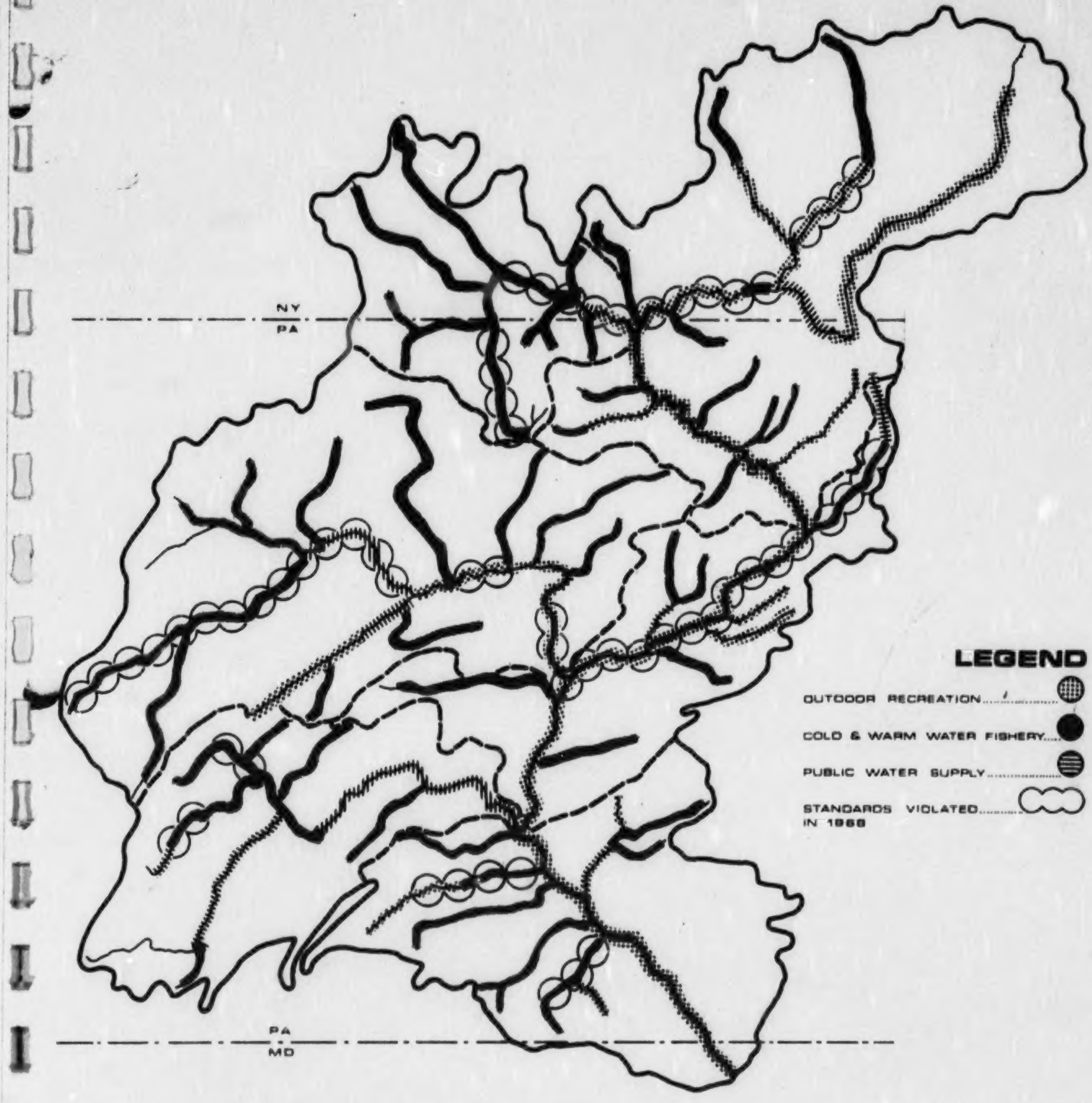


WATER QUALITY STANDARDS

standards for intrastate streams reflect
wishes of water-use task group, 1965-66

The primary objective is to provide a water quality management program for all the major uses of water. Water resource management takes into consideration a balance among all the legitimate uses as well as the enhancement of water quality. In general, the quantity of water available in the Susquehanna River Basin is ample, but pollution in many places restricts specific uses. Occasionally, there is insufficient quantity because of low flows and in these instances some streams are undependable for use as water supplies, trout fisheries, or for the proper assimilation of organic wastes.

This program is intended to implement the water quality standards so that the streams are returned to or maintained in a state of high quality. Many streams in the basin are still of relatively high quality; they are high in dissolved oxygen and generally display viable and desirable ecosystems. Along with programs to achieve established standards, every effort should be made to maintain these high quality streams in their present condition. Standards set for intrastate streams should be equally as stringent as the interstate standards.

Water Quality Standards

In all three states, stream classifications and related criteria are based on the best use of water as determined by the agencies responsible for the clean water programs. Their decisions were arrived at after hearings held with the local citizens. The three states generally require secondary treatment of all municipal and industrial wastes discharged into interstate streams.

Stream Classifications in the Susquehanna Basin

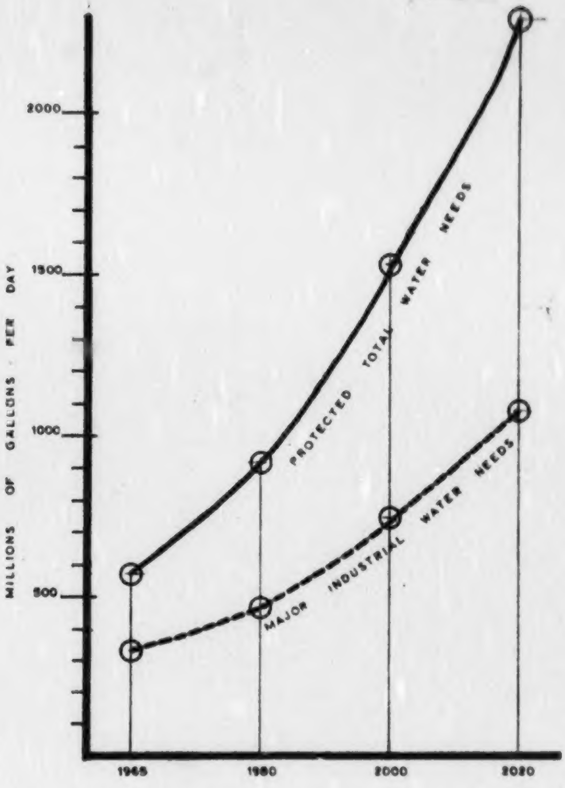
	New York	Pennsylvania	Maryland
Water Supply	Class AA, A	2.0	II
Aquatic Life	Class C	1.0	II, III
Recreation	Class B	3.0	III
Other	Class D	4.0	---

All three states are also active in preparing and implementing standards in intrastate streams. These standards generally conform to the level of quality required in the standards on interstate streams.

Present and Future Requirements

Estimated future demands of water for municipal and industrial uses were based upon the 88 water service areas. It is estimated that by 2020 at least three times as many people will be served by expanded services within areas and the accompanying demand is expected to be about six times greater than it is at present. Industrial demands are expected to increase less than the municipal demands, but will still require about three times as much water as they do today. The total represented by these demands will amount to 2.5 billion gallons of water per day by 2020 as compared to a usage of six billion in 1965.

Two water services outside the basin presently divert large quantities of water; the Chester area in Pennsylvania and Baltimore in Maryland are the recipients of this water. A potential third major diversion exists in the proposed Mason-Dixon Authority which hopes to meet the increasing demands of the southeastern Pennsylvania and northern Maryland by tapping the Susquehanna. In 1968, the Chester and Baltimore



future needs for municipal and industrial uses demands totaled a little over 80 million gallons per day. By the year 2020, however, these demands, plus the demands of Maxon-Dixon Authority and Havre de Grace in Maryland, are expected to exceed 800 million gallons per day, ten times present demands.

In addition, there are thirteen water services within the basin itself that will have to expand significantly to meet the expected increased demands. These will have to be met for the most part by developing further the supplies from nearby rivers.

Cortland --- Tioughnioga River
Binghamton --- Susquehanna River
Hornell --- Canisteo River
Elmira --- Chemung River
Scranton --- Lackawanna River
Altoona --- Little Juniata River
State College --- Spring Creek
Carlisle --- Conodoguinet Creek
Lebanon --- Swatara Creek
Ephrata --- Cocalico Creek
Lancaster --- Conestoga Creek
York --- Codorus Creek
Hanover --- Codorus Creek

It is relatively easy to estimate the cost and worth of the water supplied to municipal and industrial demands. It is also relatively easy to estimate the number of people that will require access to open bodies of water for recreation, but it is difficult to fix a dollar value on recreation and aesthetically pleasing surroundings in general. These can only be measured in terms of time spent by people at recreational activities. At the present time, nearly four million people use the basin's water resources to occupy their leisure time. Pleasure boating alone accounts for almost six million user-days per year and other water-related, recreational activities total more than 25 million days a year.

As the number of people increases and they find they have more leisure time their demands on the basin's water resources will increase. The Bureau of Outdoor Recreation expects this demand to increase about six-fold by 2020. These figures do not include fishing demands, which now stand at about six and a half million user-days a year. The number of days spent in fishing is expected to increase to about 23 million by 2020.

In the final analysis, man-days of recreation are the benefits realized. The basin's recreation potential is enormous, but poor water quality restricts full use. When the water quality management objectives are attained, then the increases described above become feasible and recreational potential will expand towards meeting these projections.

ORGANIC WASTE

Sub-basin	Pop. Equiv. Before Treatment	Pop. Equiv. After Treatment	Pop. Served by Sewers	Pop. Without Trt. Fac	Pop. With Primary Trt. Fac.	Pop. With Secondary Trt. Fac.	Pop. With On-lot Trt. Fac.
Chemung	265,000	76,000	125,000	3,400	34,000	88,000	125,000
Upper Susquehanna	303,000	197,000	222,000	9,000	210,000	3,000	278,000
Middle Susquehanna	958,700	502,000	643,000	316,500	272,300	54,200	113,500
West Branch	549,700	346,000	168,400	26,500	101,200	40,700	178,600
Juniata	307,900	87,000	129,800	3,300	43,700	82,800	202,200
Lower Susquehanna	1,273,900	345,000	484,800	2,200	209,100	273,500	468,200
TOTAL	3,658,200	1,553,000	1,773,400	360,900	870,300	542,200	1,365,500

SOURCES AND PROBLEMS

Municipal and Industrial Wastes

Three major river segments are seriously degraded by organic wastes from industrial and municipal sources: the Susquehanna for 20 miles below Binghamton, and for 30 miles below Wilkes Barre, and the Chemung River for 10 miles below Elmira. In these reaches, the dissolved oxygen levels have been as low as 1.0 mg/1. In addition 24 tributary streams suffer from excessive organic waste loadings. The effects of organic loadings are most evident during the warm months of the summer when high stream temperatures and low stream flows coincide. Organic wastes originate from some 130 principal concentrated sources as well as from many minor sources. After treatment, wastes from the equivalent of 1.5 million people are emptied into the Susquehanna river and its tributaries.

Major industrial wastes emanate from eight pulp and paper mills, three large chemical plants, and several large food processors. Of these, the most significant organic pollution problems originate at the Kraft process pulp mills listed below:

Paper Pulp Mill	Receiving Stream	Stream Low Flow (cfs)	1965 Waste Discharge (cfs)
P.H. Glatfelter (Spring Grove)	West Branch Codorus Creek	19.4	15.6
Westvaco (Williamsburg)	Frankstown Branch	71	4.7
Westvaco (Tyrone)	Little Juniata	59	8.4

Paper Pulp Mill	Receiving Stream	Stream Low Flow (cfs)	1965 Waste Discharge (cfs)
D.M. Bare Division of Combined Mills (Roaring Spring)	Halter Creek (to Frankstown Branch)	12.7	6.7

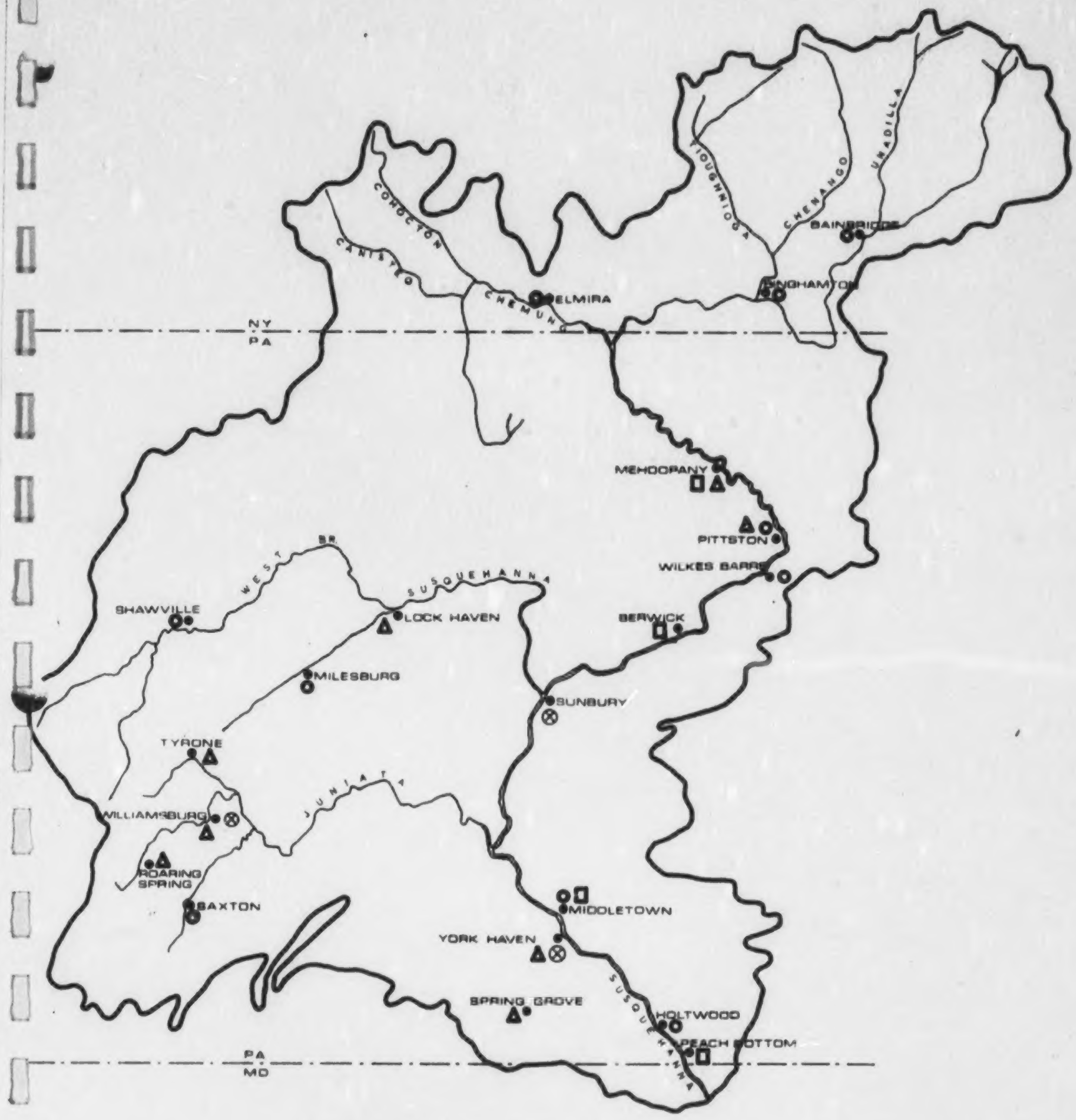
The other paper mills cause less serious problems because they discharge to larger receiving streams.

Company	Process	Receiving Stream
Charmin Paper Co. (Mehoopany)	(ammonia sulfite base)	Susq. River
Swanee Paper Corp. (Ransom, Pa.)	Waste paper reclamation	Susq. River
International Paper Co. (York, Pa.)	Waste paper reclamation	Susq. River
New York Pa. Co. (Lock Haven)	Waste paper reclamation	Bald Eagle Creek

The principal chemical discharge to the Susquehanna originate at the Merck Co. and Allied Chemical Co. in the Danville (Pa.) area. The Lebanon Chemical Corp. discharges to the Lebanon (Pa.) municipal treatment plant causing overloads at the plant.

Principal Food Processors

Company	Location and Receiving Stream	Treatment Facility	Degree of Treatment
Ann Page, Division of A & P	Elmira (Newtown Creek)	Chemung County District #1	Secondary
Chef Boy Ardee Div. Home Products Corp.	Milton (W. Branch)	Own	Primary
Zeussner Cheese	New Holland (Mill Creek)	New Holland Municipal	Secondary



PULP & PAPER MILLS AND THERMAL DISCHARGES

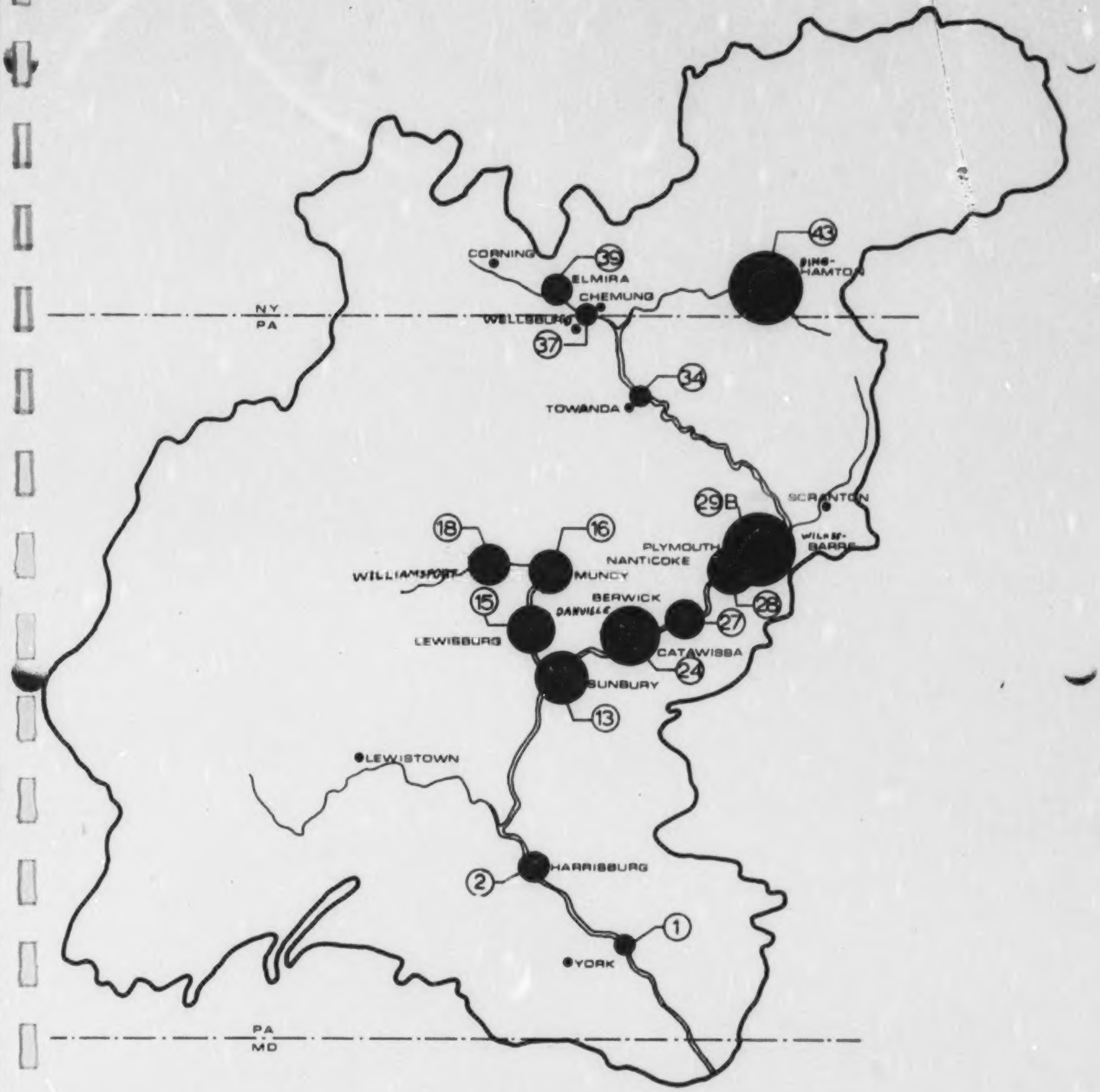
LEGEND

pulp & paper mill effluents .... ▲

thermal discharges .... ⊗

current plants to be phased out by 1990 .... ○

future plants .... ▯



BACTERIOLOGICAL SAMPLING NETWORK

The size of the circle generally indicates severity of bacterial count. The maximum counts were 160,000/ml. at Wilkes-barre and at Binghamton. The lowest count indicated here occurred near York, 11,900/ml. (summer 1967)

Company	Location and Receiving Stream	Treatment Facility	Degree of Treatment
Grimes Poultry Processing	Fredericksburg (Elizabeth Run)	(Individual)	Primary
Musselmans Div. Pet Milk Co.	Boylerville (Conewago Creek)	(Individual)	Secondary
Wise Potato Chips Co.	Berwick (Susq. River)	Berwick Municiapal	Primary
Utz Potato Chips Co.	Hanover (Conewago Creek)	Hanover Municipal	Secondary

Coliform counts are highest in reaches below discharges from concentrated population centers. Condition effluent in the area around Endicott, the Susquehanna below the Tri-city area, comprising Binghamton, Johnson City, and Endicott, far exceed permissible limits for water contact recreation. High coliform/fecal coliform counts were in the river reach also found between Wilkes-Barre and Sunbury. This latter situation is of special significance becuase of the large recreational development planned at the junction of the main river and its West Branch at Sunbury.

ABATEMENT

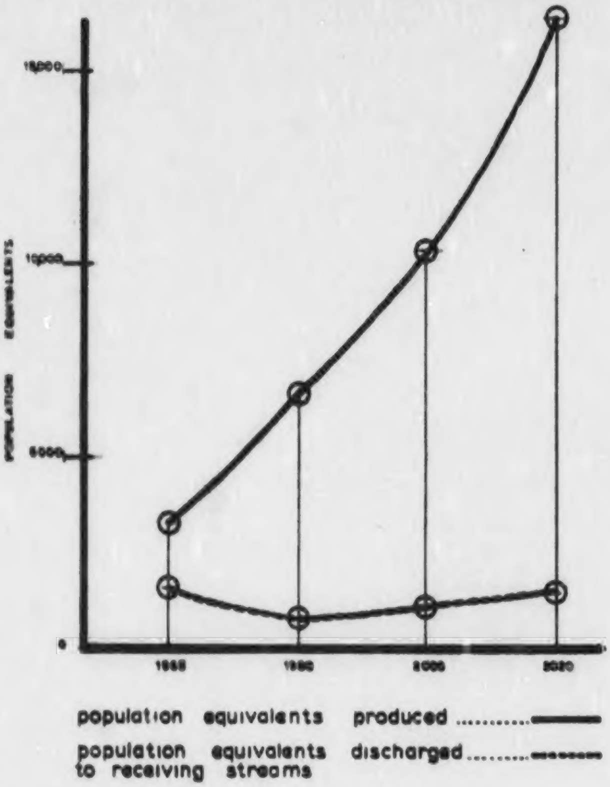
Municipal and Industrial Wastes

Municipalities and industries should provide a minimum of secondary treatment for waste discharges as soon as possible. Further measures are required in specific situations and these are detailed in the sub-basin section of this report.

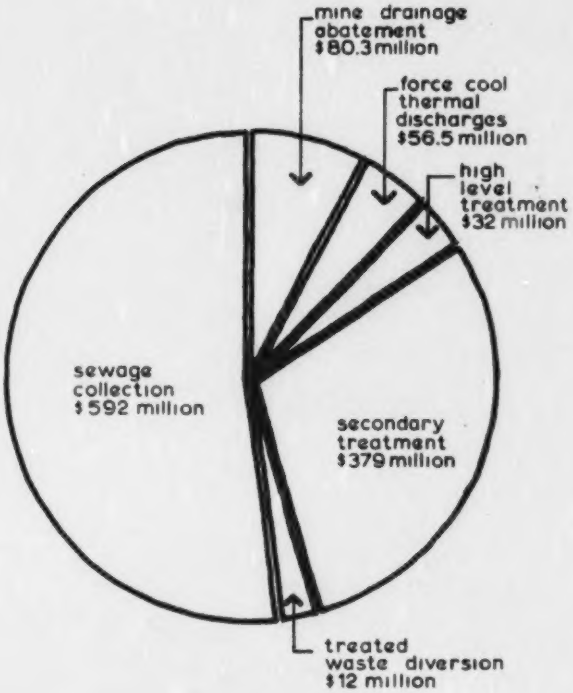
After the level of secondary treatment has been installed, it is projected that 30 sewage service areas, outlined in the sub-basin sections of this report, will require high level BOD removal. Nineteen of the 30 sewage service areas could be partially or entirely spared of the expense of the extra treatment requirements by properly managed flow regulation. In the other instances, there is no substitute for higher treatment.

The equivalent of secondary treatment should be provided in all cases of significant industrial waste production. In addition to high level BOD removal, color removal is also required at the four Kraft process paper mills. These mills (D.M. Bare, two Westvaco Plant, and Glatfelter) discharge their wastes after secondary treatment to small streams. Regardless of secondary treatment these plants still cause stream pollution. Their wastes consist of large quantities of colored materials that can be removed by any of three methods: massive lime process, lime mud contact, and land application. All three possibilities should be studied in detail before a method is selected for any of the plants. Preliminary studies indicate that land application may be the least expensive alternative to high level BOD removal at the other three paper mills. These are the D.M. Bare Company at

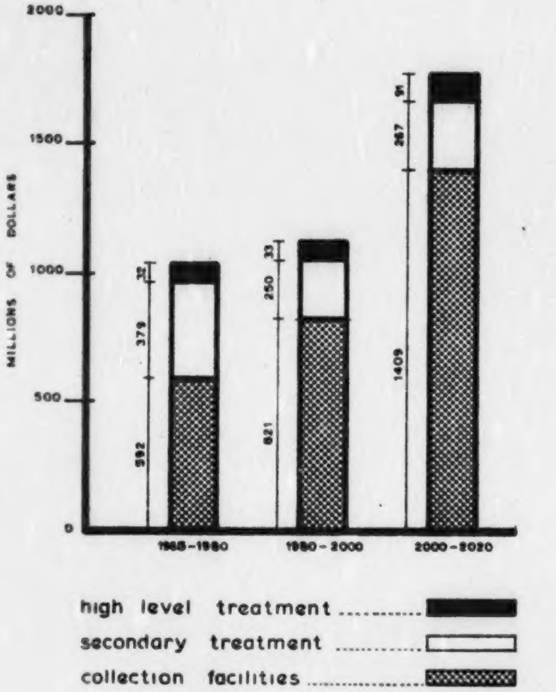
anticipated efficiency of proposed facilities to treat organic wastes



costs of recommended abatement measures (1965 - 1980)



projected costs of clean water*



* COST OF TREATMENT FACILITIES FOR ORGANIC WASTES

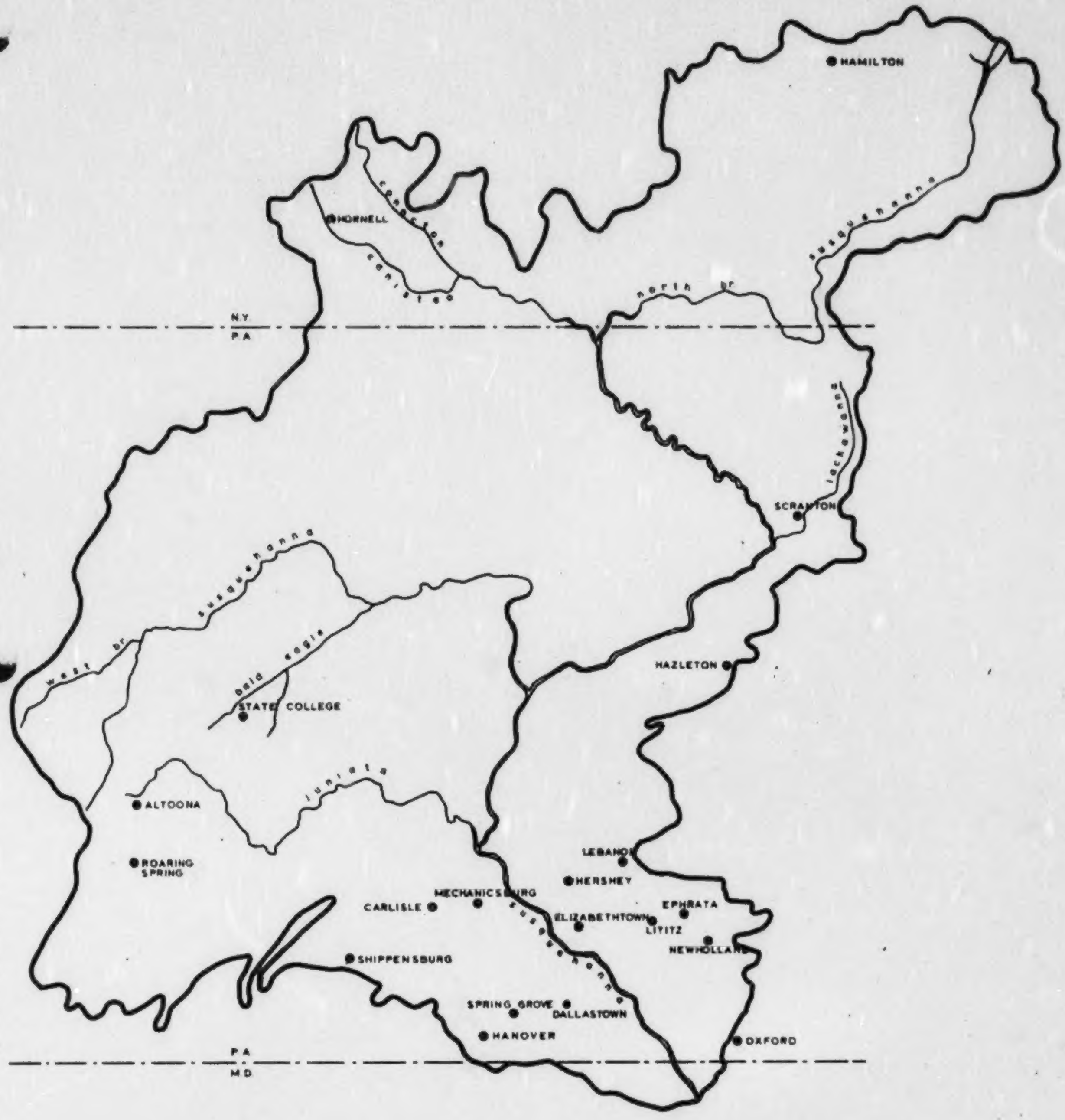
Roaring Spring, the Westvaco operation at Tyrone and Williamsburg . All three treatment processes and any later developed method should be evaluated in detail before a method is selected for any of the locations.

The Glatfelter Company at Spring Grove was evaluated on the basis of a comparison between massive lime contact process and treated waste diversion. It appears that diversion of treated waste from both Spring Grove and York is the most positive and economical solution to achieving clean water in Codorus Creek.

Food processors and chemical factories discharging to municipal secondary treatment plants should first provide pre-treatment. The most serious offenders are Ann Page Foods in Horseheads (N.Y.), Zaussner Cheese of New Holland, Lebanon Chemical in Lebanon, both in Pennsylvania.

Large Dischargers to Small Streams

High levels of BOD removal are required at 22 large discharges located in the headwater areas. The water from 19 of these communities should be treated by high level BOD removal. Land application of the effluent from secondary treatment plants appears to be an alternative to high level BOD treatment. Although the possibilities have not been thoroughly worked out and the costs are are not precisely known, there would be enough water from the secondary treatment plants to irrigate over 7700 acres at an average application rate of two inches per acre per week. This would minimize the total acreage used and still avoid clogging the soils. Used to maximize crop production,



PLACES WHERE IRRIGATION COULD SUPPLEMENT TREATMENT about 15,000 acres could be irrigated at an average rate of 20 inches per year during the growing season, May through September. Land application would have the added advantage of providing irrigation water and distributing nutrients to farm and forest lands.

Regional Treatment

Costs and waste assimulation needs as evaluated for this report assumed regional treatment of wastes at one point and discharged to the stream at one point. Where a large, point discharge was difficult for the stream to assimilate, the sewage service area was split into two or more sewage areas (examples: three service areas around Binghamton, four around Scranton, two around Harrisburg West Shore).

Although economies can be realized from large scale operations, political and topographical considerations will often dictate more than one sewage treatment plant in a given sewage service area. Therefore, waste assimilations studies tended to be somewhat conservative.

Installation of secondary treatment will be accompanied by appropriate collection facilities and is estimated that between 1965 and 2020 6.2 million additional people will be served by sanitary sewers.

Collection Facilities *

Time Period	1000's Pop. Equiv. Served	Costs in Millions of Dollars		
		Collective Facilities	Secondary Treatment	High Level Treatment
1965-1980	6796	592	379	32
1980-2000	10036	821	250	33
2000-2020	15240	1409	267	91

* Costs do not reflect nutrient removal.

Low Flow Regulation

There are seven stream reaches where quality might be enhanced by flow augmentation during the months of July, August, September, and October. These are described in the following table. Even with the presumed 85 percent BOD removal at all sewage service areas in the upper Susquehanna, the organic waste loadings in the reach below Binghamton will still be so heavy that flow augmentation will be a virtual necessity during the low flow months of the year. In the reach below Middletown, water quality degradation is predicted to occur from excessive organic loadings complicated by anticipated thermal discharges from power generation facilities.

FLOW NEEDS AT SELECTED LOCATIONS

		(Assuming 85% BOD Removal) Flow Required to Maintain 5.0 mg/l (cfs)			
Stream Reach	Target Year	Jul.	Aug.	Sept.	Oct.
Tioughnioga below Cortland	2000	99	93	74	51
	2020	158	148	119	83
Susquehanna below Binghamton	2000	405	376	305	223
	2020	740	682	560	410
Chemung below Elmira	2000	334	312	252	174
	2020	538	505	405	282
Lackawanna below Scranton	2000	145	135	104	80
	2020	203	189	150	122
West Branch below Lock Haven	2000	558	518	486	200
	2020	700	656	610	261
Conodoguinet Creek below Carlisle	2000	29	26	21	18
	2020	49	45	38	33
Susquehanna below Columbia*	2000	3400	3200	2100	1600
	2020	4200	3800	2500	1800

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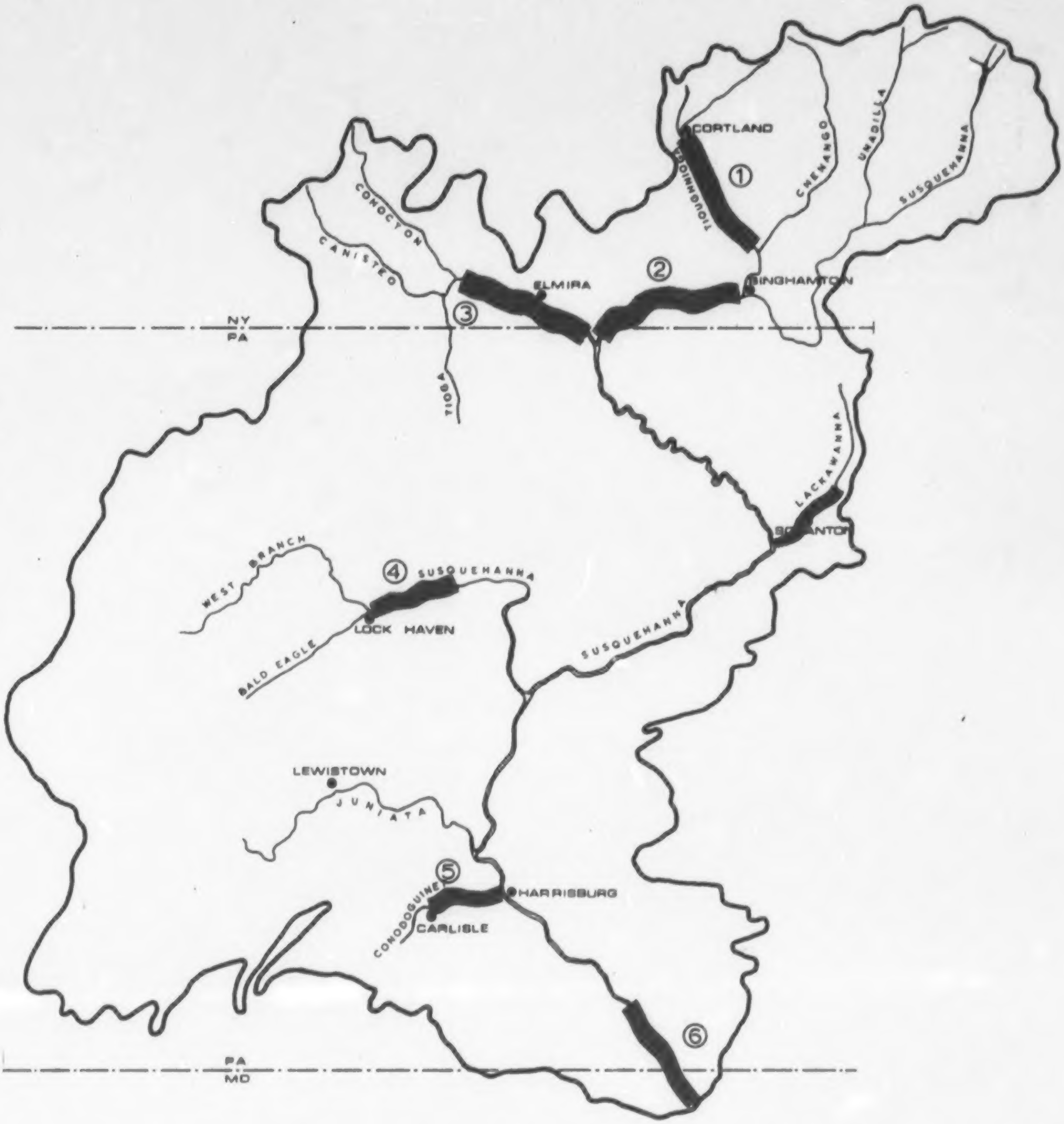
* Assuming steam electric plants have sufficient forced cooling capability to hold heat rise within 5 F.



REACHES WHERE FLOW REGULATION IS A POSSIBLE SOLUTION

Flow regulation needs are based upon waste projections to 2020, predicated upon a BOD removal reaching at least 85 percent. The objective in making additional water available to these reaches is to achieve and maintain a minimum of 5.0 mg/l dissolved oxygen in the river reaches receiving the flow augmentation, thereby maintaining water quality standards.

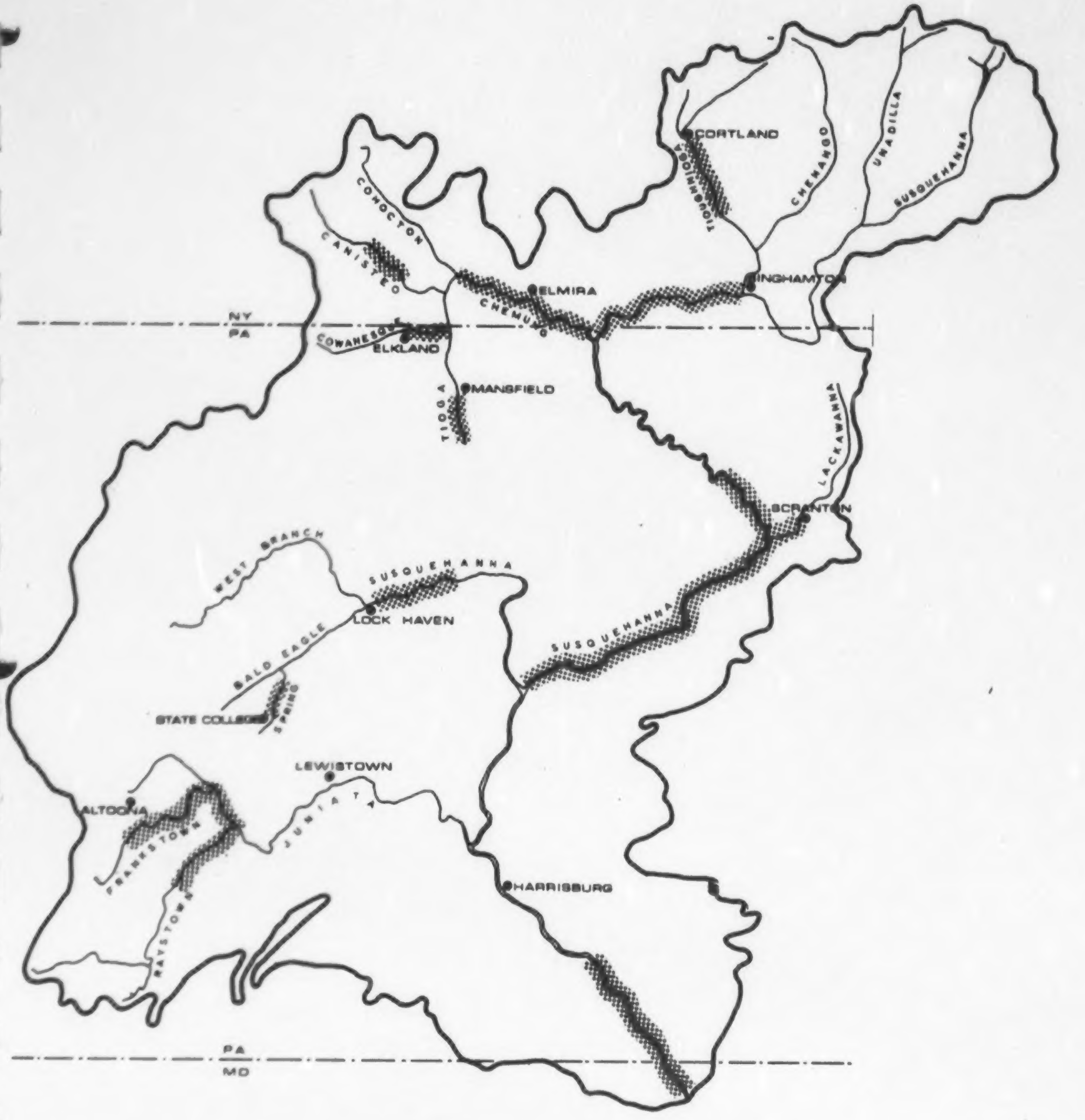
Flow regulation was studied as an alternative to high level BOD removal on the Frankstown Branch and on the West Branch below York Haven. However, costs for reservoir sites in these areas tend to be higher for the same results than costs for high level BOD removal.

Surveillance

Surveillance during low flow and high water temperature periods is recommended for the following reaches.

Susquehanna below Binghamton
Susquehanna below Mehoopany and Wilkes-Barre
Susquehanna below Middletown
Tioughnioga below Cortland
Chemung below Corning and Elmira
Cowanesque below Elkland
Tioga below Blossburg and Mansfield

Significant water quality indicators for these areas include dissolved oxygen, temperature, fecal coliforms, suspended solids, nutrients, as well as for pesticides and industrial pollutants in certain locations. Surveillance activities should also be expanded



REACHES WHERE SURVEILLANCE IS RECOMMENDED

for those reaches below sewage service areas recommended for high level BOD and nutrient reductions. (see sub-basin details)

Surveillance is also important for river stretches downstream from communities with combined sewers. Special studies should be conducted concurrently where extension of these systems is contemplated.

SOURCES AND PROBLEMS

Nutrients

Detrimental effects from excessive nutrient loadings have been observed in a number of stream reaches throughout the basin. The most serious algae and weed problems exist in Spring Creek below State College; Raystown Branch below Bedford; Susquehanna below Binghamton; Chemung below Elmira; Susquehanna below Wilkes-Barre; Conodoguinet below Carlisle; Quittapahilla below Lebanon; Conestoga below Lancaster; and Codorus below York. Map locations and a listing of the most significant nutrient sources are given on the following pages.

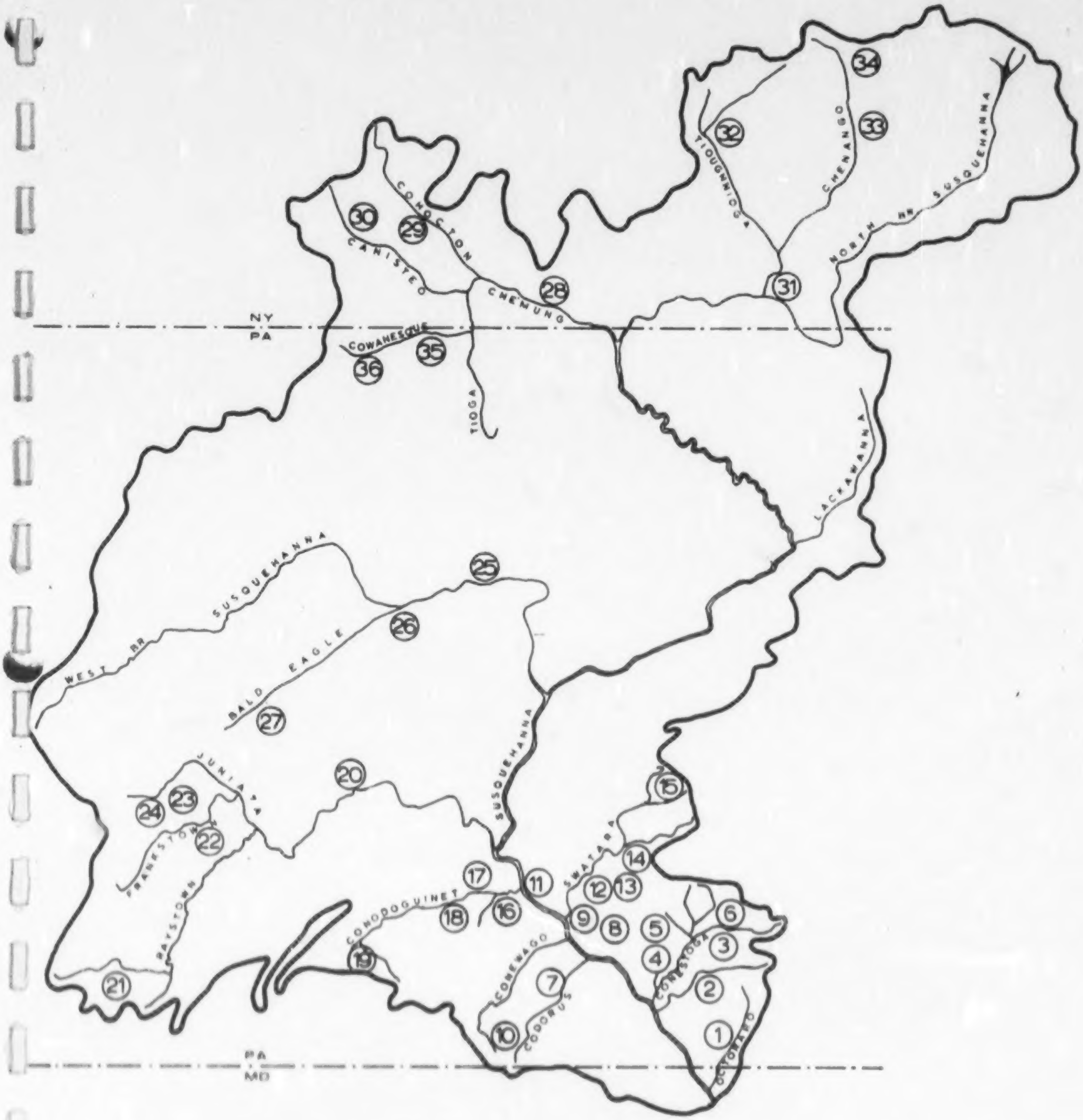
Nutrients arising from intensified agricultural activity enter the Susquehanna from watersheds in the lower sub-basin, essentially below Harrisburg. Using 0.4 mg/l PO_4 concentrations as an indicator of significant phosphate concentration, it was found that watersheds with 35 percent or more land under intensive cultivation contribute phosphate levels associated with the nutrient pollution. At present, however, nutrient loads from agricultural activity alone do not seem to cause serious algae and aquatic weed growths.

Chesapeake Bay Relationships: The water in the area where the Susquehanna enters the bay is very shallow and for a long time it was scoured out each year by ice flows from the Susquehanna. These scourings helped in establishing a varied and desirable ecosystem. But when the Conowingo Dam was constructed, the scourings ceased and conditions conducive to rooted aquatics prevailed with the result that Eurasian milfoil, an undesirable plant, began to take over. This was not the sole organism by any means, but it was predominant until attacked and virtually wiped out by a natural virus disease. The organism was replaced, for a time, by another undesirable organism, anacystis, a blue-green alga. The ecosystem, including both of these species as well as some that are desirable under such conditions, are indicators of increased rate of aging.

There is evidence of an influx of nutrients from the Susquehanna, however. Algal counts at Conowingo have been as high as 42,000 per milliliter. These counts indicate that nutrients do take effect in the lower sub-basin and are further substantiated through reports of algal blooms in pools of the lower sub-basin. The sources of nutrients are primarily the large municipalities of the lower sub-basin and its tributaries. The tributaries causing the largest problems are Octoraro, Conestoga, Codorus, Conodoguinet, and Swatara Creeks.

PRINCIPAL SOURCES OF NUTRIENTS

1. Oxford
2. Agricultural Runoff
3. New Holland
4. Lancaster and Agricultural Runoff
5. Lititz
6. Ephrata
7. York
8. Elizabethtown treatment plant
9. Agricultural runoff (farms near Elizabethtown)
10. Hanover
11. Harrisburg Area
12. Hershey
13. Agricultural Runoff (farms near Hershey)
14. Lebanon
15. Fredericksburg
16. Mechanicsburg
17. Agricultural Runoff (farms near Hogestown)
18. Carlisle
19. Shippensburg
20. Lewistown
21. Bedford
22. Williamsburg
23. Altoona (NE)
24. Altoona (SW)
25. Williamsport
26. Lock Haven
27. State College
28. Elmira
29. Bath
30. Hornell
31. Binghamton Area
32. Cortland
33. Norwich
34. Hamilton
35. Elkland
36. Westfield



SOURCES OF NUTRIENT LOADS

ABATEMENT

Nutrients

Some degree of nitrogen and phosphate reduction should be required at all significant sources of nutrient production. Studies should be undertaken to assess the costs and to establish priorities among the sewer service areas that may require this kind of treatment. The degree of removal required should reflect the current and anticipated extent of the problem downstream. A separate report on the data concerning nutrients is in preparation, which will describe the present conditions on nutrients throughout the basin.

An evaluation should be made of nutrient loadings leaving the Susquehanna and entering Chesapeake Bay. For the Susquehanna Flats, little is known at the present time about the interrelationships among nutrients, oxygen, and population shifts within ecosystems to make concrete statements on exactly what should be done to alleviate the nutrient loads. Studies are needed to expose and define these interrelationships. Associated studies are also needed to determine the oxygen needs to maintain a desirable ecosystem in the Flats.

SOURCES AND PROBLEMS

Thermal Pollution

At present, only localized pollution due to heated discharges occurs within the basin. Up to 1968, water quality temperature standards are definitely violated at only one location: Shawville on the West Branch, a stream badly polluted with mine acids. However, several large atomic and fossil-fueled plants are scheduled for construction and these will require greater quantities of condenser cooling water. The most serious thermal pollution problems will occur in the lower sub-basin unless adequate forced cooling systems are used.

Presently the largest thermal load is being discharged from the Brunner Island fossil-fueled plant situated downstream from the York Haven hydroelectric dam. The river is broad and deep at this point, and up to 1968 had been able to dilute the heated water satisfactorily. In 1969 this plant, owned by the Pennsylvania Power and Light Company, will increase its capacity to 1520 MW and require about 1100 cfs of river flow for its condenser cooling system--twice what it has been using. At present there are no provisions for cooling this wwter before returning it to the river. This plant, along with the plants near Milton and Sunbury, Pennsylvania, are expected to be the major fossil-fueled steam electric plants in the future.

Six more plants scattered throughout the basin cause localized thermal problems during low flow periods, but most of them are tentatively scheduled to be phased out by 1990. The Shawville plant in the West Branch sub-basin discharges enough hot water to create a complete thermal barrier to migratory fish, but the stream at this point is too acid to allow them.

Future electric power will be generated from fossil-fueled and atomic plants, as well as hydroelectric dams. All of the major dam sites on the lower Susquehanna River have been taken, but none have been developed to their fulles. Prior to 1975, it is anticipated that the Holtwood and Safe Harbor hydroelectric plants will be expanded so that they will be capable of using approximately the same flow (82,000 cfs) as the Conowingo hydro-station uses at its peak power generation; the Conowingo is presently the largest "run-of-river" hydroelectric plant in the Susquehanna River Basin. A pumped storage facility at Muddy Run, associated with the Conowingo power facility, will be expanded to generate 800 MW. It is anticipated that in the future similar pumped storage facilities will be developed, e.g, the Stoney Creek facility near Harrisburg.

Large atomic plants will be in operation on the shores of the York Haven Pool and the Conowingo Pool. Two of the units will be built by the Metropolitan Edison Company along the York Haven Pool at Three Mile Island, each with a capacity of 840 MW and each with a cooling requirement of 1000 cfs for condenser cooling. The first unit will recirculate its cooling water; the second will force cool before discharge.

The Philadelphia Electric Company is constructing two atomic stations called the Peach Bottom Plants Numbers one and two, on the Conowingo Pool that will have a total capacity of 2200 MW and will require 3700 cfs of water for condenser cooling. They will be in operation by 1975 using forced cooling systems for cooling the water before it is returned to the pool.

The water will be returned by means of discharge pipes placed into the deep water of the reservoir, but even with this precaution, there will still be some warming of the pool.

As the fossil-fueled facilities are phased out, other atomic plants will take up the slack and provide power for increased demands. An atomic plant will probably be located near Berwick by the Pennsylvania Power and Light Company. This company also has plans to install a large fossil-fueled plant near Lewisburg, Pennsylvania. It will be located in the watershed of a tributary to the West Branch and will recirculate its cooling water so that no discharge to the West Branch will result.

An atomic power development is planned by the Pennsylvania Electric Company below Towanda, Pennsylvania. The Pennsylvania Power and Light Company is planning two additional atomic plants, each with a capacity of 1100 MW, but the sites for these plants have not yet been selected. It is very likely, however, that they will be located in the basin.

ABATEMENT

Thermal Pollution

To meet the stream standards, which allow only a 5 F rise in the receiving stream after mixing, all new steam-electric plants should install forced cooling systems. The efficiency and capacity to force cool should be designed according to stream flow and temperature conditions at each specific site.

The situation in the lower Susquehanna sub-basin below Middletown is potentially the most serious. Even with secondary treatment of all wastes directly discharged to the lower Susquehanna, the waste loads are expected to be nearly ten times greater in 2020 than they were in 1965. The addition of heated waters will magnify the depressing effect organic wastes have on dissolved oxygen. Studies by the FWPCA show that dissolved oxygen levels are affected by water temperature, oxygen demanding organic wastes, and river flow. Even with high level BOD removal of waste loads discharged directly to the river, flows during low flow periods will not be large enough to maintain 5.0 mg/l dissolved oxygen in the face of organic loads as water temperatures approach 90 F.

Organic Wastes Discharged to the Susquehanna below Middletown

	1965	2000	2020
Population Equivalents Treated	20,000	420,000	774,000
Population Equivalents Discharged	13,000	63,000*	116,000*

* After secondary treatment

Stream Flow Requirements for 5 mg/l Requirement* (cfs)

Temperature	85% BOD Removal	95% BOD Removal
77 F	1640	1300
86 F	4270	2700
95 F	10,900	8900

* The once-in-20-year, August low flow at Conowingo is 3500 cfs.

The maintenance of adequate dissolved oxygen levels will require high level BOD removal coupled with cooling systems that hold the temperature within the 5 F allowed. This might be favorably effected by flow augmentation. Eventually the maintenance of DO in the pools of the lower Susquehanna River should be accomplished by a mix among flow regulation, high level BOD removal, and temperature control.

There are basically three kinds of cooling systems that can be considered in relation to the degree of temperature control desired. With each one, the flow needed to meet DO requirements varies with degree to which organic wastes are removed.

	Flows Required in August* - (cfs) monthly avg. temp.	
Cooling Systems	Wastes Receiving 85% BOD Removal	Wastes Receiving 95% BOD Removal
Run of River	9900	6900
Forced Cooling (hold rise to 5 F)	4300	2700
Closed System	2500	1700

* The once-in-20-year, August low flow at Conowingo is 3500 cfs.

The combined annual cost of closed cooling systems at the Three Mile Island, Brunner Island, and Peach Bottom plants is estimated to be about

3.3 million dollars more than combined costs for forced cooling to hold heat rise to 5°F. High level BOD removal is estimated to cost nearly a million dollars annually more than secondary treatment.

Forced cooling systems are also recommended for the Shawville plant of the Pennsylvania Electric Company and the Milesburg plant of the West Penn Power Company. The Shawville situation is contingent upon abatement of mine drainage in the Upper West Branch.

SOURCES AND PROBLEMS

Combined Sewers and Stormwater Runoff

Forty-two sewage service areas presently used combined storm water and sewage collection facilities. These areas are listed in detail in the sub-basin sections.

Further study is needed to determine the extent of nutrients, bacteria, and organic wastes that occur as a result of combined sewers. Previous observations indicate that the most serious pollution of this type occurs in the Binghamton and Wilkes-Barre areas.

ABATEMENT

Combined Sewers and Stormwater Runoff

It is known that correction of existing combined systems is quite expensive. Therefore, all new sewage collection extensions should be separated.

Abatement of the existing problem areas should be undertaken in this manner:

1. Monitoring of receiving streams to ascertain the extent of the problem.
2. Engineering studies to estimate corrective methods and costs.
3. Establishment of priorities.

There are a number of correctional methods presently under consideration in research programs.

1. Off-system storage for excessive flows. This can be accomplished by using rubberized fabric bags located in the receiving stream and by using underground tunnels in metropolitan areas. The latter, however, is an extremely expensive method. The objective of storage is to hold the runoff until flows subside and the treatment plant can manage the load. In considering these storage systems, thought must be given to removing the accumulation of sludge and sediment.

Ponds can also be used for off-system storage and simultaneously serve as stabilization lagoons so that wastes will not have to be recycled back into the treatment plant. Even with storage systems, however, there may be an occasional overflow to the receiving stream. To counter any health hazards, chlorination at appropriate discharge points will reduce bacterial counts.

2. In-system storage can also be used effectively. An array of monitors and regulators can be installed throughout the collection system to withhold flows from conduits already at peak capacity.

3. Another in-system modification is the "sewer-within-a-sewer" where the sanitary sewer is suspended from the top of the storm sewer, thus separating the two kinds of sewage flow.

4. Another technique is to increase flow throughout treatment plants by using polymers developed for use as lubricants.

Mine Drainage

Mine drainage causes gross water quality degradation in over 600 miles of rivers and streams in the Susquehanna River Basin. It is also the cause of intermittent degradation in an additional 635 miles of streams and rivers, depending on flow conditions. Mine drainage produces a precipitate of iron hydroxide that coats the stream bottom and acid that exerts its damaging effects by destroying desirable ecosystems.

A rough breakdown of the relative quantity of mine drainage pollution constituents arising from the two coal fields shows that about 55 percent of it comes from the bituminous coal fields in the West Branch, Juniata, and Tioga Rivers, with the remaining 45 percent originating in the anthradte fields of the Middle Susquehanna area. The damaging constituents of mine drainage are iron hydroxide, increased acidity (with the accompanying lowered pH), and sulfates. The necessary ingredients for formation of these constituents are air, water, and iron sulfite. In the company of certain bacteria, which are suspected of contributing to the physico-chemical process forming the mine drainage, these substances interact and eventually produce the low pH usually accompanied by the visually graphic iron hydroxide which precipitates on stream bottoms and imparts to them an orange to red color. The emphasis on strip mining in the bituminous area has caused not only aesthetically repulsive scars on the landscape, but has also contributed to the formation of mine drainage. Strip mining operations do not respect the boundaries of natural watercourses. The once-pristine creeks are intersected and often diverted through the coal field where the water picks up the pollution constituents.

A further problem in the strip mining is that of deep mine interception, which occurs when the operation intersects a previously abandoned deep mine. In these cases, natural drainage patterns are interrupted and the water may either flow into or out of the deep mine, giving it an additional opportunity to pick up the pollution load.

Field investigations conducted during this study identified 1150 mine drainage discharges, of which 970 originate at inactive mines. These inactive mines contribute about 820,000 pounds of acid per day, which is about 75 percent of the basin's total acid loading per day. Five hundred sixty thousand pounds of quicklime would be required each day to neutralize this much acid. Deep mines are a greater source of acid loading than strip mines, producing about 714,000 pounds of acid a day.

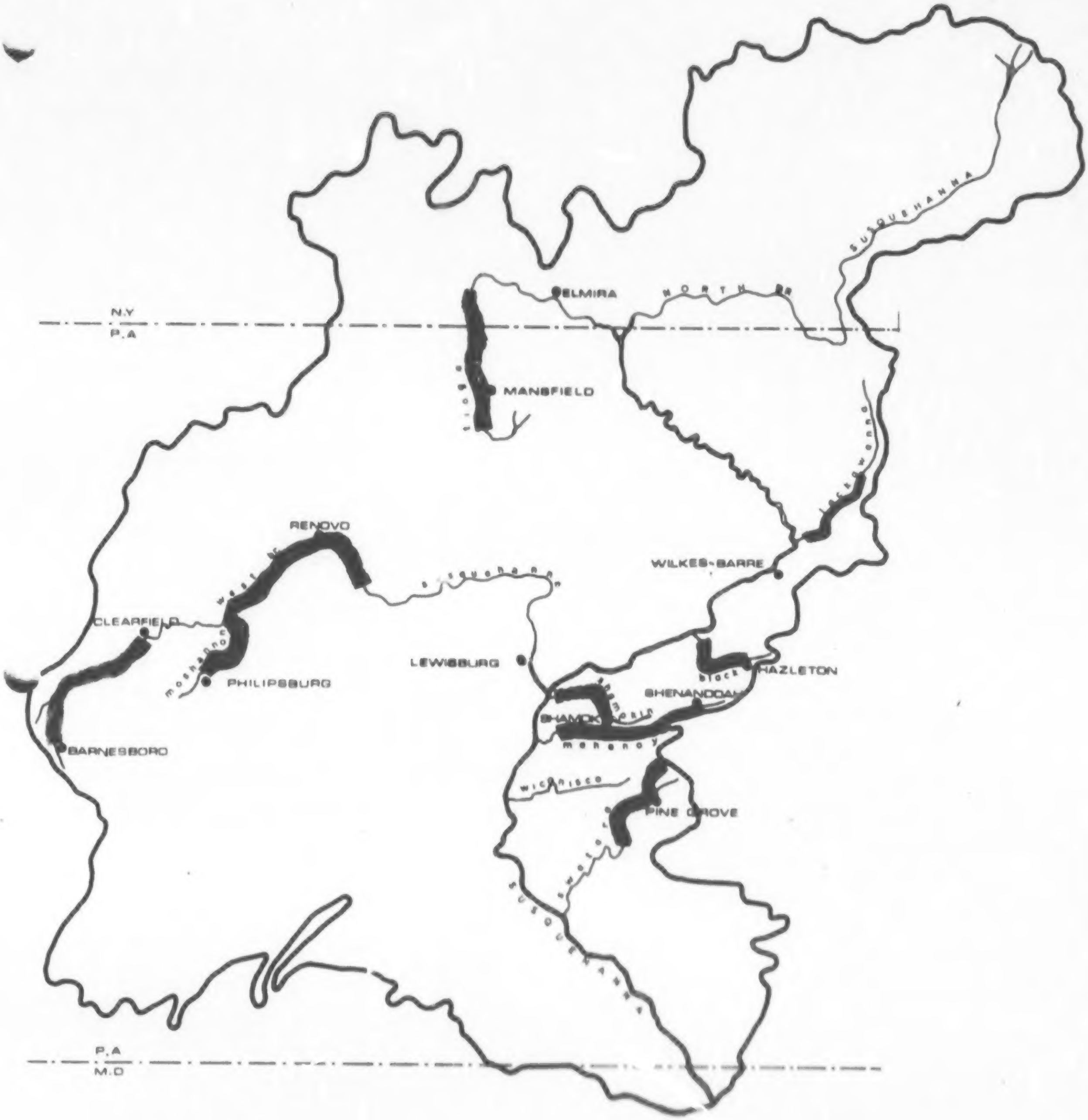
In the Middle Susquehanna sub-basin, acid pollution from mine drainage in the Susquehanna and Lackawanna Rivers is complicated by organic pollution from communities in the Wyoming and the Lackawanna River Valleys. After the suppressing effects of the mine drainage disappear, the organic waste and nutrients begin to act again as pollutants, depressing oxygen levels and causing unnaturally heavy growths of algae and aquatic weeds.

Acid impregnated streams, other than the Lackawanna and Middle Susquehanna, significantly polluted by organic wastes are: Black Creek below Hazleton, Shamokin Creek below Shamokin, Mahanoy Creek below Shenandoah, Swatara Creek below Pine Grove, Moshannon Creek below Philipsburg, and the Upper West Branch below Barnesboro.

In some ways the anthracite coal region poses greater mine drainage and associated problems than the bituminous region. There are a greater number of deep mines in the anthracite area as well as a greater number of inactive deep mines. The latter fact alone indicates there are probably more mine drainage sources than presently known and also that the sources may have greater potency in terms of mine drainage constituents. A complicating factor also is the interconnection of many of these deep mines.

Data collected up to this time can be used as a basis for several conclusions:

1. Known discharges in the anthracite field are fewer, but individually contribute a much larger loading per discharge than those in the bituminous field.
2. In both fields, abandoned mines are a more significant source of mine drainage pollution constituents than active mines.
3. In the anthracite field, strip mines are not a primary source of mine drainage.
4. In the bituminous field, strip mines are a significant source of pollution, but collectively are not as significant as deep mines.
5. Slag heaps in the anthracite region are an enormous source of both mine drainage pollution constituents as well as sediment.



ORGANICALLY DEGRADED
ACID STREAMS

ABATEMENT

Abating mine drainage from any source involves carefully considering the factors unique to each source. Information was gathered throughout the study effort on the Susquehanna Basin, and the details are reported in *Mine Drainage in the Susquehanna River Basin (1969)*. Generally, mine drainage assessment was devoted to flow measurements, chemical analyses, geographical location, and the type of mining done at each location. The kinetics of acid streams was studied jointly by Wilkes College under contract and the FWPCA.

Concurrently, feasibility studies were carried out by the consulting firm of Gannett Fleming Corddry and Carpenter, Inc. (GFCC), under contract to FWPCA on five small watersheds influenced by mine drainage. Each watershed closely resembles a particular kind of mine drainage situation found in the basin. Several combinations of preventive and treatment measures were evaluated, and cost estimates were made for each combination.

Preventive measures considered in the GFCC study:

1. Removal of acid-producing refuse with subsequent burial of the refuse in strip mined areas.
2. Reduction in discharge volume from point sources.
    - a. Reconstructing stream channels.
    - b. Backfilling selected strip mines.
    - c. Restoring subsided areas.
    - d. Applying bentonite or asphalt layers to selected areas.
    - e. Constructing surface water diversions.
    - f. Water seals for deep mines.

3. Covering refuse areas with some impervious material like asphalt.

Treatment measures considered:

1. Lime nuetralization.
2. Reverse osmosis.
3. Electrodialysis.
4. Ion exchange.
5. Distillation.

Using prevention followed by treatment, the reduction of acidity is expected to range from 20 to 70 percent. Prevention methods generally are aimed at controlling mine drainage at the source. Treatment methods are intended to reduce the amount of acid in the discharge or in the stream. Control at the source should be the first priority.

The recommendations for treating mine drainage rely largely on neutralization through precipitation with lime which, under present technology, is considered the most feasible treatment alternative. However, treatment is used only to eliminate the acid remaining after preventive measures have been in effect. While lime will neutralize the acid, other effects on stream quality which may result are not clearly predictable. Disposal of the sludge resulting from the blending process presents a difficult disposal problem. The abatement measures reflected in these cost estimates require an estimated 82,000 tons of calcium oxide (quick lime) per year. Present use of lime for all purposes in the basin is estimated at 720,000 tons per year. The quick line needed for acid neutralization would require about a ten percent annual increase in lime used.

Initially, abatement should be directed towards the projects with the highest benefit potential which can be undertaken with available funds. Thus far no satisfactory scheme has been devised to estimate all the potential benefits associated with mine drainage abatement. There are, however, two very good examples of real damages resulting from acid mine drainage pollution. If mine drainage were abated, municipal and industrial supplies could realize a savings of over one million dollars annually by having streams presently degraded by mine drainage available for water supply. Agricultural enterprises could realize an estimated 85,300 dollars annually by being able to irrigate acreage next to acid streams. The monetary value of recreation and aesthetics are difficult to express, but the losses suffered here may be greater than those that can be expressed in monetary values. It is estimated that among the rewards for abating mine drainage pollution is an increase in fishing areas. There will be an estimated addition of 600,000 fishing days per year which could conceivably result in more than two million dollars spent annually on fishing needs and accessories.

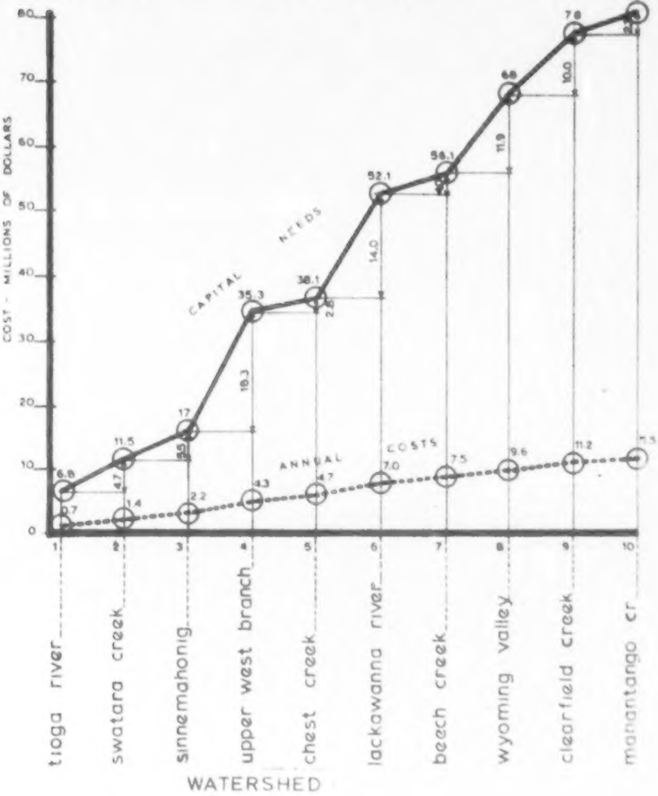
Costs for Mine Drainage Abatement

Cost estimates are based on design data for the five selected watersheds studied in detail for the abatement of mine drainage. The costs are related to acid flows and pounds of acid produced per day, as well as to pounds of iron produced daily, the type of mining, and the nature of the surface disturbance. In each case, estimates reflect an optimum mix of preventive measures followed by treatment of the excess acid remaining. The cost estimates reflect abatement of mine drainage to the extent required by the Pennsylvania Sanitary Water Board. In practice, however, the abatement can proceed in a step-by-step fashion accompanied by downstream monitoring until a satisfactory quality situation is attained in the reach in question.

Under a basin-wide program on 27 watersheds, mine drainage will cost about 226 million dollars initially. The table below describes the average annual costs, including capital recovery and operation and maintenance, to the greatest extent possible, with lime neutralization to meet water quality standards.

	Capital Costs - $ Millions		
Sub-basin	Preventive Measures	Collection and Treatment	Total
Chemung (Tioga River)	3.75	3.02	6.77
West Branch and	57.08	69.79	126.86
Juniata	2.42	14.06	16.49
Middle Susquehanna (incl. Swatara Creek)	26.75	49.13	75.88
TOTAL	90.0	136.0	226.0

estimated costs of mine drainage abatement, based upon recommended priority schedule (first ten priorities)



The interagency effort on water resource development for the Susquehanna River Basin (Corps of Engineers' Type II Study)[1] included a work group devoted to mine drainage abatement. This work group developed a priority system of benefits that would be realized from mine drainage pollution abatement. This system considered benefits to water supply, outdoor recreation, fish habitat, irrigation, and reduction of corrosion potential. Weights were assigned according to length and width of stream and proximity to population centers. Benefits to be accrued were compared with the estimated cost. Priorities were assigned mostly on the best benefit-cost ratio, though partially on the basis of committee judgment.

In conjunction with this work group's findings, 12 watersheds are recommended for immediate abatement. Action on these watersheds will effect proportionately the greatest benefits at the lowest cost, with priority placed by consideration for benefit-cost and least cost per accumulated value.

	First Cost*		Annual Cost		O & M Cost	
Rank Watershed	Cost.	Cumm.	Cost.	Cumm.	Cost	Cumm.
1. Tioga River	6.77		0.71		0.35	
2. Swatara Creek	4.69	11.46	0.73	1.44	0.46	0.81
3. Sinnemahoning Creek	5.48	16.94	0.78	2.22	0.46	1.27
4. Upper West Branch	18.32	35.26	2.04	4.26	1.02	2.29
5. Chest Creek	2.79	38.05	0.38	4.64	0.22	2.51
6. Lackawanna River	13.99	52.04	2.27	6.91	1.41	3.92
7. Beech Creek	3.96	56.00	0.54	7.45	0.31	4.23
8. Wyoming Valley	11.95	67.95	2.12	9.57	1.32	5.55
9. Clearfield Creek	10.03	77.98	1.63	11.20	1.01	6.56
10. Mahantango Creek	2.33	80.31	0.31	11.51	0.18	6.74
11. Loyalsock Creek	0.43	80.74	0.12	11.63	0.09	6.83
12. Beaverdam Branch	5.24	85.98	0.52	12.15	0.23	7.06

* All costs are in millions of dollars.

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[1] Interagency Coordinating Committee Study on Susquehanna River Basin.

SOURCES AND PROBLEMS

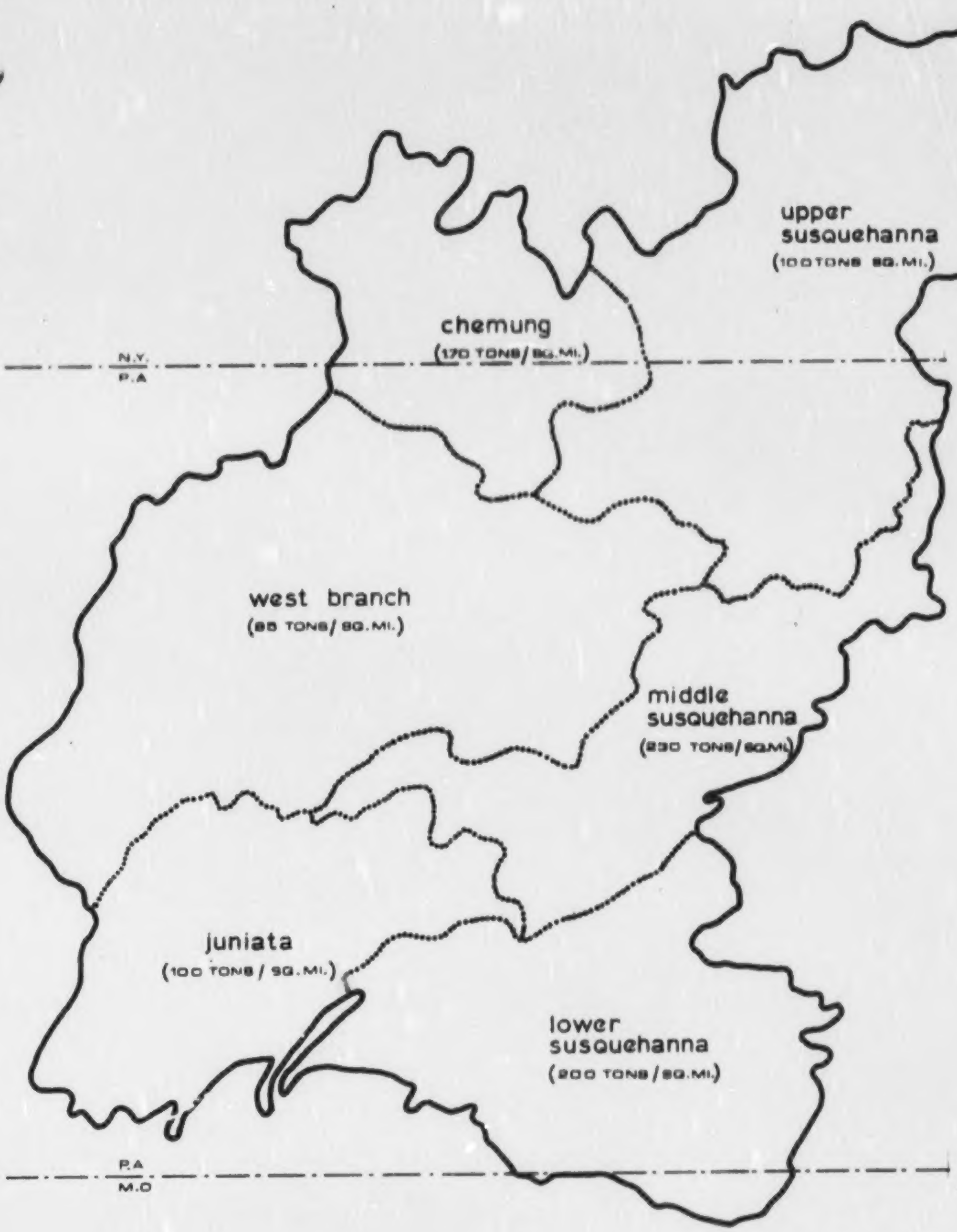
Sediment

Sediment problems in the basin are more of a local than a general nature. However, sediment trapped behind the Safe Harbor Dam in the lower sub-basin indicates the high sediment production caused by past coal mining operations. During the period from 1961 to 1966, an average of over 800,000 tons of sediment materials were removed from Safe Harbor Dam annually. Two-thirds of this was in the form of coal fines. The Geological Survey of the Department of the Interior has made sediment discharge measurements indicating that about three million tons of sediment annually are carried by the river system, but about 75 percent of this is trapped behind the Safe Harbor, Holtwood, and Conowingo Reservoirs of the lower sub-basin.

The Middle Susquehanna sub-basin is where the greatest sediment loads occur in the form of coal fines. In this region, coal was commonly brought to the surface and washed and refined and the refuse piled in slag heaps near the mine entrance. These slag heaps, subjected to the environmental elements, form continuous sources of both sediment and mine drainage constituents for the waterways of the region.

There are also heavy sediment loadings from the intensively farmed lands of the Lower Susquehanna sub-basin and are a contrast to streams draining the heavily forested areas in the West Branch and Juniata sub-basins. These carry a lower sediment load, demonstrating very well how important land use patterns are in controlling this pollutant.

These sediment loads, like any other kind of pollution, require an extended length of the receiving stream for mixing. For example, lateral



TYPICAL SEDIMENTATION RANGES IN TONS PER SQUARE MILE FOR A MAJOR STREAM IN EACH ZONE

MAP SHOWING THE SUSQUEHANNA RIVER BASIN AND BASIN SUBDIVISIONS FOR THE STUDY AREA stratification of suspended materials at Harrisburg occurs in such a fashion that the concentration on the east side of the river can be as high as 170 mg/l while only 90 mg/l is carried by the waters on the west side. Lateral stratification also keeps the sediment from the anthracite region nearest the east side of the Susquehanna. In the areas that are extensively farmed, soil types as well as farming practices have an effect on the sediment loading of the receiving stream. Sedimentation is associated with nutrients because it is a poblem on the same watersheds where nutrient loadings are high.

ABATEMENT

According to a Department of Agriculture report, abatement of seciment originating on farm land should be undertaken on 3.2 million of the 4.2 million acres devoted to crops. Modern conservation methods, such as stripcropping, contour plowing, etc., should be employed to cut down on soil erosion from croplands. Soil erosion from grasslands can be reduced through planting with new, vigorous varieties and by using the latest techniques and chemicals in fertilizing. Sediment arising from urban development and highway construction is best controlled at the source. Local authorities should be encouraged to press for controls within their jurisdictions.

Sediment from mining areas is also best controlled at the source through planting a vegetative covering on the refuse piles. By keeping the water out of contact with mine tailings, sedimentation can be almost completely controlled.

SOURCES AND PROBLEMS

Federal Installations

Only 41 of the over 150 federal installations in the basin produce more than 1000 gallons of waste per day. Most federal installations are connected to local municipal facilities. This is in compliance with the requirements of the Federal Executive Order No. 11288 requiring all establishments either to connect to local municipal treatment facilities or to provide their own treatment equivalent to secondary.

Six of the installations presently are not in compliance with Executive Order No. 11288. The Veteran's Administration Center in Bath, New York, discharges domestic waste after primary treatment to the Cohocton River. The section of the river receiving the discharge is designated as fishing waters in New York's water quality standards.

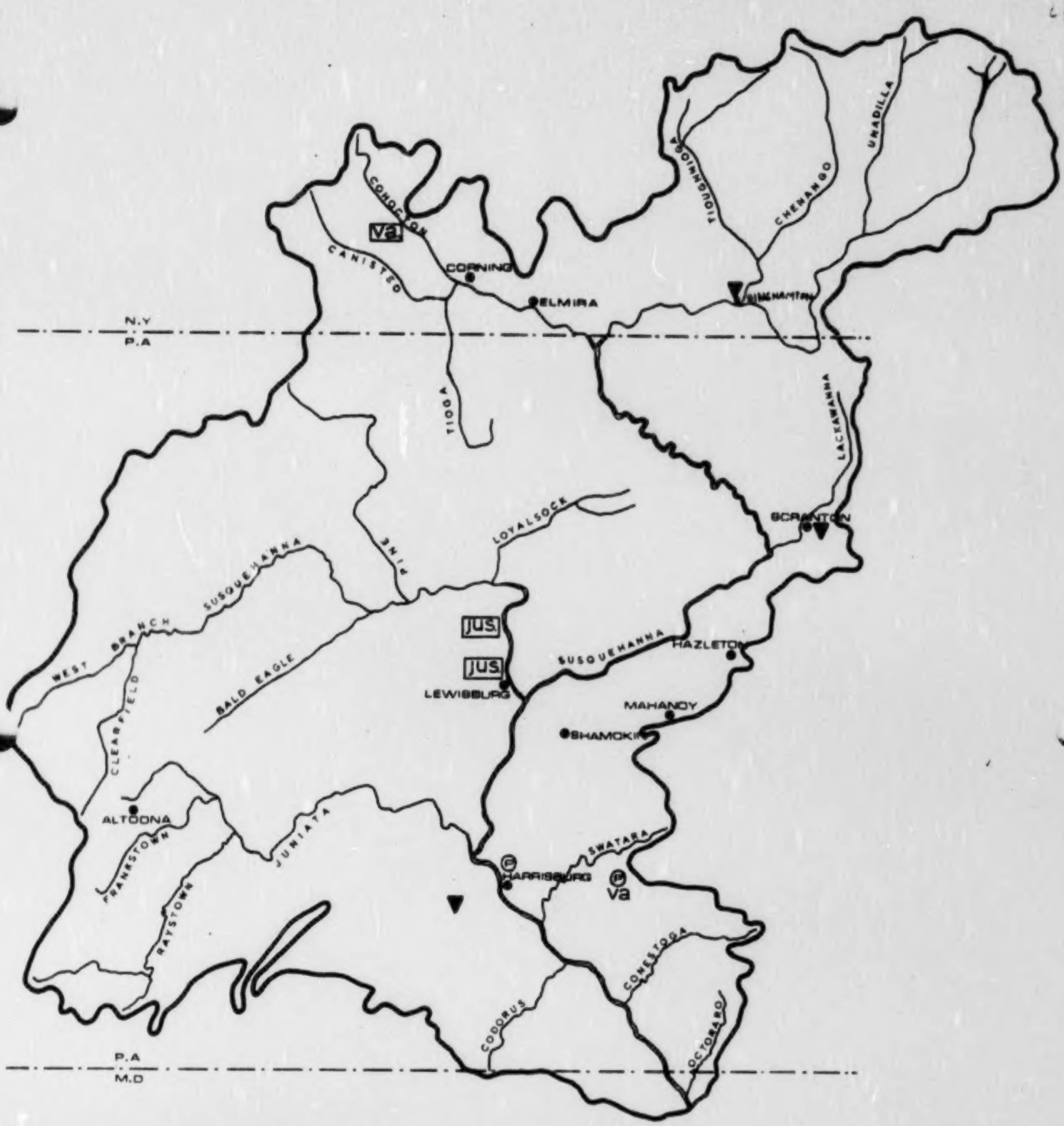
The Upper Susquehanna River is the receiving stream for approximately 6000 gallons per day of domestic wastes from the Property Management and Disposal Depot in Binghamton. The waste receives primary treatment before being discharged to the Upper Susquehanna. The river is designated by New York's water quality standards as a source of public water supply, but criteria are not being met at present in this reach of the river.

The Scranton Army Ammunition Plant in the Middle Susquehanna sub-basin produces industrial as well as domestic waste. The discharge is made up primarily of domestic waste, boiler blowdown, process water, and a thermal discharge. The process water contains alkalies, phosphates, and chromates.

There are two federal installations in the West Branch, both managed by the Justice Department and both in violation of Executive Order No. 11288.

The Allenwood Federal Prison Camp uses a septic tank system with a drain field that is designed for about half as many people as there are who use it. The discharge is received by Black Hole Creek which suffers degradation as a result. The sanitary wastes of the Lewisburg Federal Penitentiary are now being treated by a secondary plant on the premises. This secondary plant, built in 1932, is overloaded; and remedial action needs to be undertaken immediately. There is also some industrial waste produced at the Penitentiary which, on one occasion, caused damage to fish life in Buffalo Creek.

In the lower sub-basin, the New Cumberland Army Depot is the only installation that is in violation of Executive Order No. 11288. The base presently provides primary treatment before discharge to the Susquehanna River.



FEDERAL INSTALLATIONS

LEGEND

veterans administration	va.
dept. of interior	int.
office of economic opportunity	eco.
dept. of justice	jus
navy	△
air-force	▲
army	▼
post - office	Ⓟ

ABATEMENT

Federal Installations

The six installations requiring immediate remedial actions to control waste discharges have taken steps to comply with the Executive Order and the applicable water quality standards. Two of the six installations have completed their feasibility studies and are preparing plans for construction of secondary type sewage treatment plants. These two are the Allenwood Federal Penitentiary and the New Cumberland Army Depot.

A planned solution to the waste problems at the Property Management and Disposal Service Depot in Binghamton is connection to the municipal system when it becomes available. The Lewisburg Federal Penitentiary has requested funds for construction of an industrial waste treatment facility. FWPCA has recommended that the Lewisburg Federal Penitentiary investigate the feasibility of a municipal connection for its domestic and industrial wastes.

The Scranton Army Ammunition Plant, producing heated wastes, domestic wastes, boiler blowdown, and industrial process water wastes, is in the process of connecting all of the discharges, except the heated waste, to the Scranton city sewer. The plant has plans for construction of cooling towers to handle the heated waste.

The Veteran's Administration Center in Bath, New York, is reviewing the feasibility of connecting to the Village of Bath municipal treatment system. The Village has extended a proposal to the Veteran's Administration which is now being reviewed by the Washington Office of the Veteran's Administration.

SOURCES AND PROBLEMS

Individual Waste Disposal Systems

There will be an increase in rural population in the sub-basin. By 1980, rural population using septic tanks is expected to grow to 132,000 and by 2020 it will increase to 188,000.

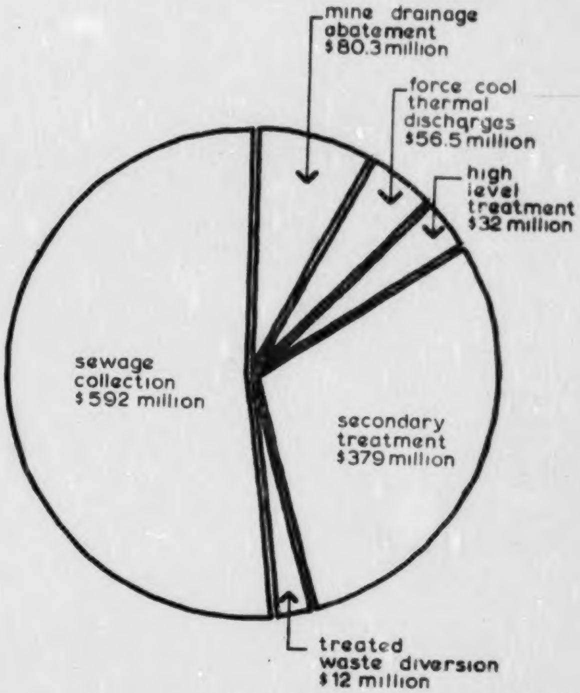
ABATEMENT

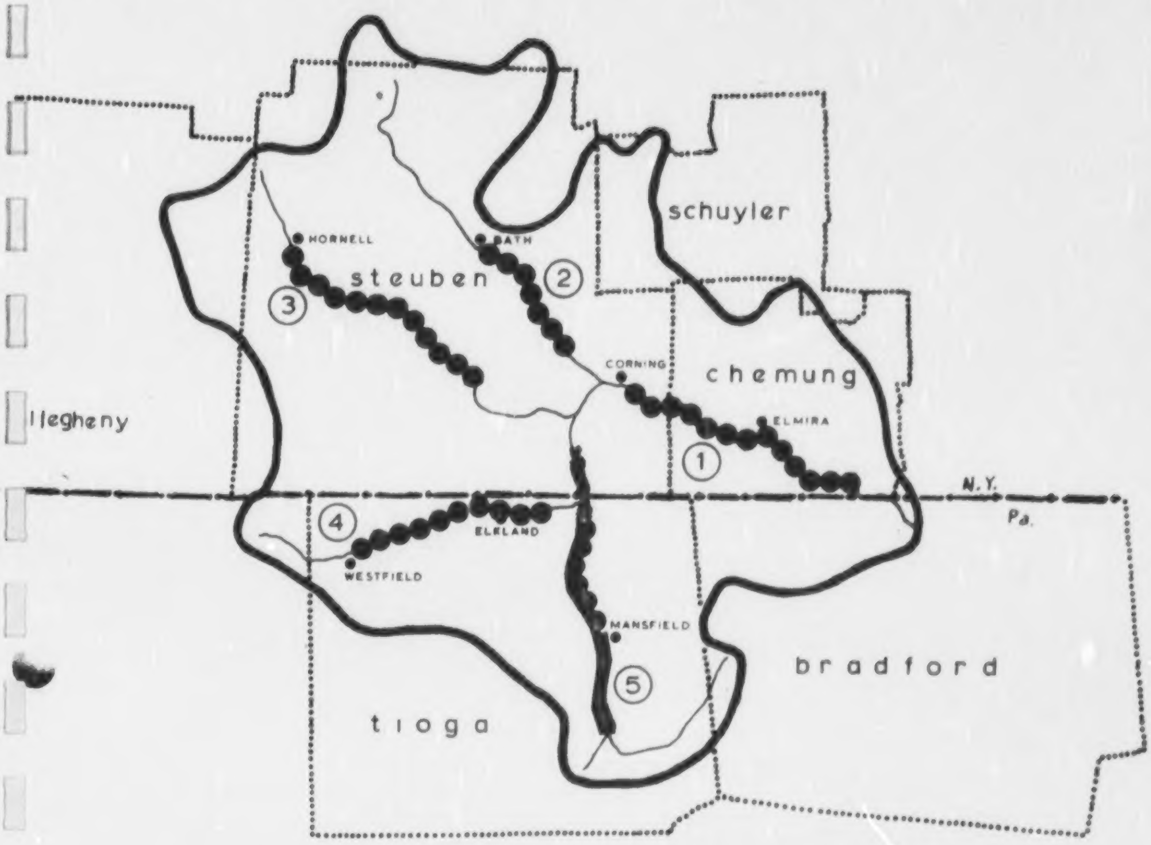
It may not be feasible for the entire rural population to connect to regional treatment facilities, but wherever possible, people are encouraged to do so. Both New York and Pennsylvania administer laws to regulate septic tank use where tank capacity and drain field construction vary with soil type, lot size, and living-quarters capacity. These kinds of facilities can be very efficient when properly designed and maintained.

Attainment of water quality management objectives revolves ultimately around local, state, and federal programs to control industrial, municipal, and mine drainage pollution. These states have already included local political units in planning and pollution curtailment programs and have in many places undertaken surveillance activities to assure the efficiency of water treatment facilities. These programs are supplemented by cooperative efforts among the states such as those embodied in the still pending Susquehanna Compact.

The piegraph indicates basin-wide clean water funding needs from all sources for six separate pollution abatement needs. Costs for any flow regulation measures, if adopted, would offset some of the high level treatment costs.

costs of recommended abatement measures (1965 - 1980)





CHEMUNG

LEGEND

mine drainage degradation ▬

organic degradation ●●●●

RIVERS

chemung river .... ①
cohocton river .... ②
canisteo river .... ③
cowanesque river .... ④
tioga river .... ⑤

General Description

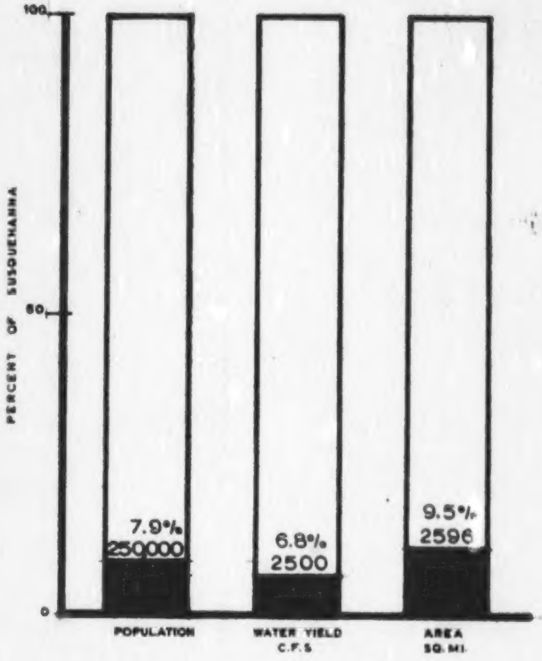
The Chemung sub-basin is characterized topographically by rolling, patternless hills and relatively wide valleys. About 50 percent is forested while much of the remainder is utilized for grassland farming. The agricultural land is marginal, however, and large tracts are being returned to forest. The streams alternate between swift rapids and placid eddys and have extremely low flows from July through November.

Much of the economic sub-region has experienced negative economic growth, except for the prosperous metropolitan communities of Corning and Elmira. About half or more of the residents live in these two communities. Total population in 1965 was 250,000 which was about 7.4 percent of the total population of the Susquehanna Basin. The population is expected to increase to 840,000 by 2020.

For purposes of this study, the Chemung was divided into seven water service areas to determine current municipal and industrial water use and to predict future concentrated demands on the sub-basin's water resources. It was divided into seven sewage service areas to determine current waste handling and treatment practices and to predict future water quality needs.

The Canisteo River downstream from Hornell, Newtown Creek in the vicinity of Elmira, and the Cowanesque River downstream from Westfield currently appear to be the most organically polluted stream reaches in the sub-basin. The Chemung itself is also somewhat degraded below Corning and Elmira. To supplement the higher level treatment facilities, the possibility of flow regulation is being considered for the reach below Elmira.

percent of total susquehanna basin



Two of the seven sewage service areas currently provide secondary treatment, four provide primary treatment and one has a collection system but no treatment. To meet the dissolved oxygen requirements of water quality standards, all should install at least secondary treatment by 1980. Hornell will need 87 percent BOD removal in the immediate future while Corning and Elmira will require high level BOD removal by 2000.

Nutrient pollition is an evident and recurring problem every summer in streams below all seven sewage service areas. The source of nutrients is primarily waste from communities. Nutrient removel will be required in the future to correct this water quality problem.

Mine drainage pollution occurs in the upper reaches of the Tioga River near Blossburg, Pennsylvania, with three tributary streams, Morris Run, Bear Creek, and Coal Creek being the major acid contributors. An area of seven square miles in the headwaters of the Tioga River, less than one percent of the total Chemung sub-basin, has been disturbed by mining operations. Mine drainage has degraded the Tioga River from Blossburg, Pennsylvania, to its confluence with the Canisteo River in New York. The significance of mine drainage is heightened by the possible adverse effects of impounding acid waters in the proposed Tioga-Hammond Reservoir. Approximately 60,000 pounds of acid per day are contributed to the Tioga River Watershed during critical late summer periods. A combination of preventive measures and treatment of mine drainage is required for control of the pollution associated with the acid waters contributed to the streams in this segment of the sub-basin.

An understanding of the surface and ground water is basic to water quality management programs commensurate with both quantity and quality for the various uses of water. In general, the quantity and quality of groundwaters and surface waters are adequate to meet anticipated water supply demands for all the water service areas except Elmira. By 1980, Elmira is expected to experience water shortages unless steps are taken to further develop groundwater resources or reservoir storage.

Waste assimilative capacities of the streams of the sub-basin are a function of flow and temperature during the critical summer season from July through October. Major tributaries of the sub-basin, shown in the following table, exhibit wide fluctuations of stream flow and clearly indicate the effects of drought conditions during the summertime on dependable stream flow. These must be considered in delineating water quality management programs for the water service areas of the sub-basin.

Stream Flow Characteristics at Selected Locations

	Flow Extreme			August Flow Data		
Stream and Gauge*	Max.	Min.	Mean An. Flow	Mean Flow	1-in-20-yr. Low Flow	Min. Daily
Tioga River at Lindley, N.Y.	75,000	6.1	781	207	33.5	28
Canisteo River at Hornell, N.Y.	9,340	7.4	154	26	8.6	7.7
Cohocton River near Campbell, N.Y.	41,100	8.0	440	115	35.5	25
Chemung River Chemung, N.Y.	132,000	49	2474	698	130	124
Cowanesque River Tioga, Pa.	25,400	0.8	273	27.7	1.0	1.3

---

* Data supplied by the U.S. Geological Survey (All measurements are in cfs).

There are also several impoundments, either existing or proposed, on streams within the sub-basin; all have multi-use potential as a part of the development program for the water resources of the study area. These impoundments are described in the table below.

IMPOUNDMENTS

Lake or Park	County	Surface Area Acres	Quality Description
Almond Reservoir	Steuben, N.Y.	124	Good
Steuben State	Steuben, N.Y.	200	Good
Tioga-Hammond Project*			
Tioga	Tioga, Pa.	570	Acid and Organic Pollution
Crooked Creek	Tioga, Pa.	640	Good
Cowanesque Reservoir Project*	Tioga, Pa.	(1)	Good**

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* Not yet completed.

** Potential for degradation exists upstream during summer, but recovery appears to be complete by time the water reaches the reservoir site.

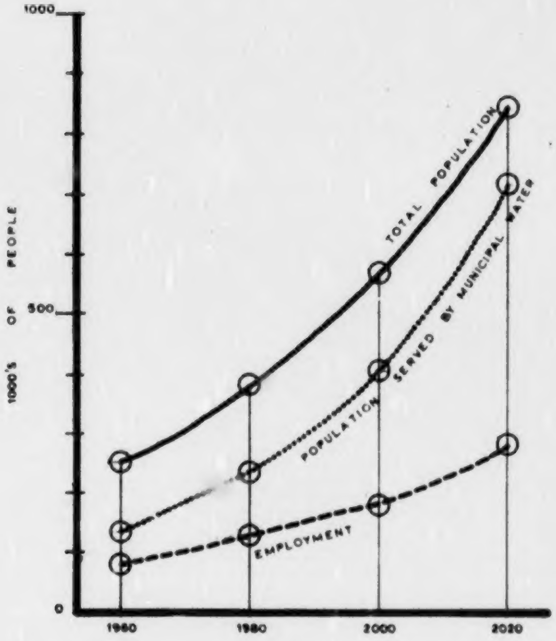
(1) Conservation storage not as yet known.

Economic Base

The Chemung economic subregion includes the New York counties of Chemung and Steuben and the Pennsylvania counties of Potter and Tioga, and its population was only about seven percent of the 1960 total basin population. Although population growth was slow during the 1950-60 decade and was accompanied by substantial net outmigration, it is projected that the population of the region will grow about 85 percent over the 1960-90 interval; this exceeds that of both the nation and the basin as a whole. The population growth will be associated primarily with the urban areas of Elmira, Corning, Bath, and Hornell in New York and in Mansfield, Pennsylvania. Potter County, Pennsylvania, will experience little growth.

Manufacturing accounted for about 41 percent of total employment in 1960 in this subregion, compared with about 26 percent for the nation and about 36 percent for the basin as a whole. Total employment is projected to grow by 92 percent between 1960 and 1990 while manufacturing employment will grow by 30 percent over the same interval. Hence, manufacturing employment will represent a small share of total employment in 1990. Although percentages vary among regions, this development is representative of a nationwide shift toward the increased importance of the non-commodity sector as a source of employment.

The industries leading in employment in 1960 were the stone, clay, and glass industry and the non-electrical equipment industry, each of which accounted for over 25 percent of total manufacturing employment. The electrical equipment sector, which experienced rapid growth during the 1950-1960 decade, represented about 12 percent. The production of population and employment trends



glass has been prominent in the area. This industry will continue to be of importance in this region. The fabricated metals industry is projected to experience rapid growth between 1960 and 1990, with employment increasing approximately 185 percent.

The electrical and non-electrical equipment industries are projected to grow moderately so that by 1990 each will employ a large share of total labor force. Employment growth in the non-electrical equipment industries should be influenced by the following factors. The region has a reasonably good location (between the primary metals manufacturing center in Pittsburgh and the Eastern markets); it has a labor pool which is experienced in the industry; and it currently produces a wide array of products which provides a diversified base for expansion.

Electronics, fabricated metals, and publishing are industries that are expected to grow rapidly. The glass producing industry has attracted electrical component manufacturers, and this industry is expected to grow at least through 1990. The fabricated metals industry will also grow in response to increased demand. Although the publishing industry will grow, it will still only represent about five percent of total employment in 1990.

In 1960, employment in textiles, primary metals, and apparel accounted for only about five percent of the total manufacturing employment. The apparel industry is projected to change very little, but textiles and primary metals are projected to decline by 1990.

Nonmanufacturing employment accounted for over 40 percent of total employment in 1960 and will account for a greater long-run expansion than manufacturing employment. It will overshadow growth in manufacturing jobs by an eight-to-one margin and by 1990 will account for more than 70 percent of total employment; by 2020, 80 percent of the jobs will be in nonmanufacturing activities.

Mining employment is now unimportant and is projected to be of little significance in the future. Mining output includes small amounts of bituminous coal, sand, and gravel.

Per capita income, in terms of 1960 dollars, is expected to increase from 1,900 dollars in 1960 to 10,000 dollars in 2020. This, however, is below the national and basin levels.

Employment in the major water using industries accounted for about five percent of total employment in 1960 and is expected to decrease by 1990. However, anticipated increases in output per employee should cause total output to expand significantly in all but the textile industry.

The following table gives the percent change in total output from 1960 to 1990 for the large water using industries.

Projected Growth in Output for Major Water Using Industries
(in percent)

	1960 to 1970	1960 to 1980	1960 to 1990
Food	73	126	334
Textiles	- 7	- 43	- 74
Paper	16	54	133
Chemicals	50	65	173
Primary Metals	34	63	127

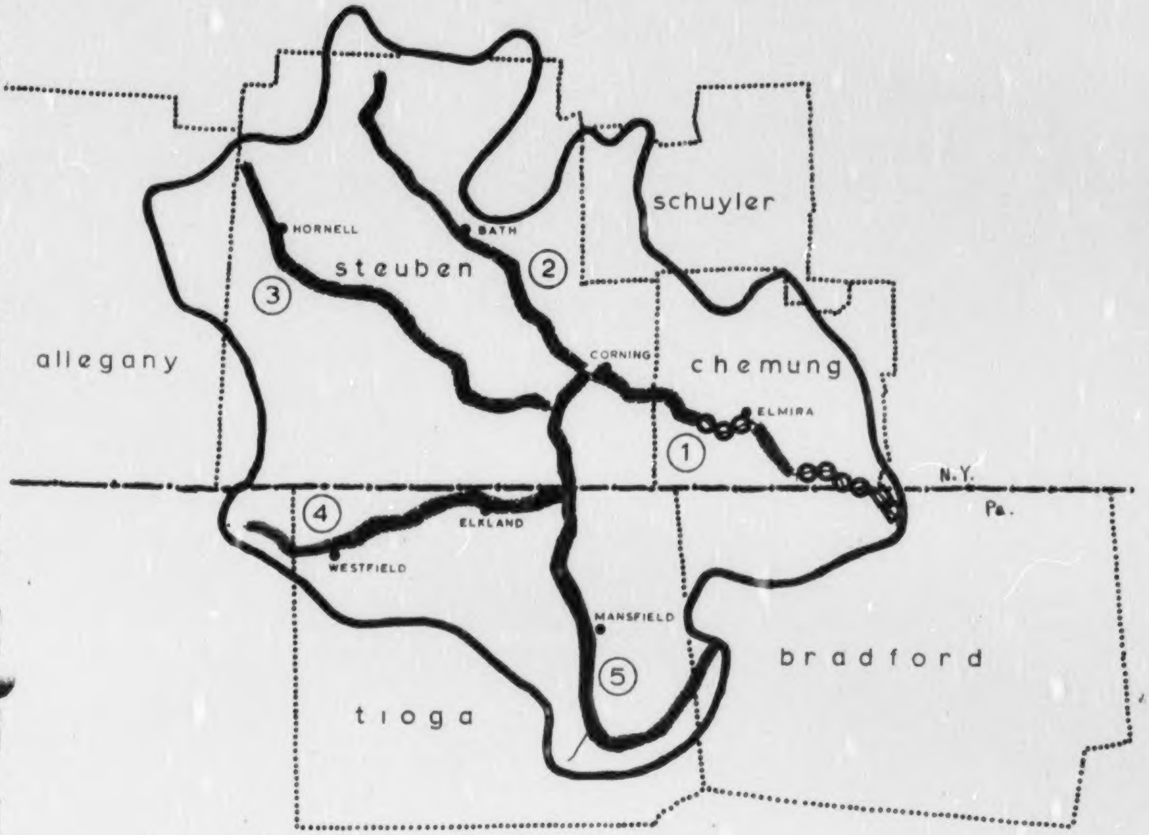
Population and industrial growth projections as summarized above were used to project future waste loadings for the Chemung sub-basin.

12

WATER QUALITY MANAGEMENT OBJECTIVES:

Present and Future Uses of Water

12
10



WATER QUALITY STANDARDS

LEGEND

cold water fishery	▬
warm water fishery	▬
public water supply	OOOO
outdoor recreation	▢▢▢▢

RIVERS

chemung river .... ①
cohocton river .... ②
canisteo river .... ③
cowanesque river .... ④
tioga river .... ⑤

Water Quality Standards

Standards for the principal interstate streams in the Chemung sub-basin have been adopted by the states of New York and Pennsylvania and approved by the Department of the Interior. These standards, based upon classifications of stream use, designate fishing as the highest use for 15 reaches in the sub-basin. About half of these are to be used specifically for trout waters. Seven reaches are presently designated as industrial or cooling water sources. Two reaches have been designated for swimming: the Cohocton River upstream from Bath, New York, and the Chemung River in Pennsylvania. Two reaches of the Chemung are classified by New York State for water supply. Pennsylvania has classified its streams in this sub-basin primarily for aquatic life habitat.

For intrastate streams still unclassified, water quality indicators used are dissolved oxygen, color, and temperature. It is assumed that dissolved oxygen will be maintained at an average minimum of 5.0 mg/l, color at a maximum of 50 units, and temperature with a maximum rise of 5°F or a maximum temperature of 87 F except for trout waters.

Recreation Uses

The recreation resources in this sub-basin are limited and the people of the area make considerable use of the Finger Lakes, which are within driving distance. The resources that are available are used intensively, but out of a total of 3720 acres of water area, only 400 are presently exploited. There are at present 800,000 user-days per year of water-oriented recreational activity.

Projected Recreation Uses

Target Year	Rec. Market Area Pop. (1000's)	Demand*		Supply*		Deficit in Water-Oriented Rec.1/
		Rec.	Boating	Rec.	Boating	
1980	355	3.62	0.42	1.36	0.06	2.26
2000	600	5.95	0.71	1.56	0.07	4.39
2020	950	11.95	1.13	1.94	0.08	10.01

---

* Million user-days per year.

1/ Water-oriented recreation demand minus supply.

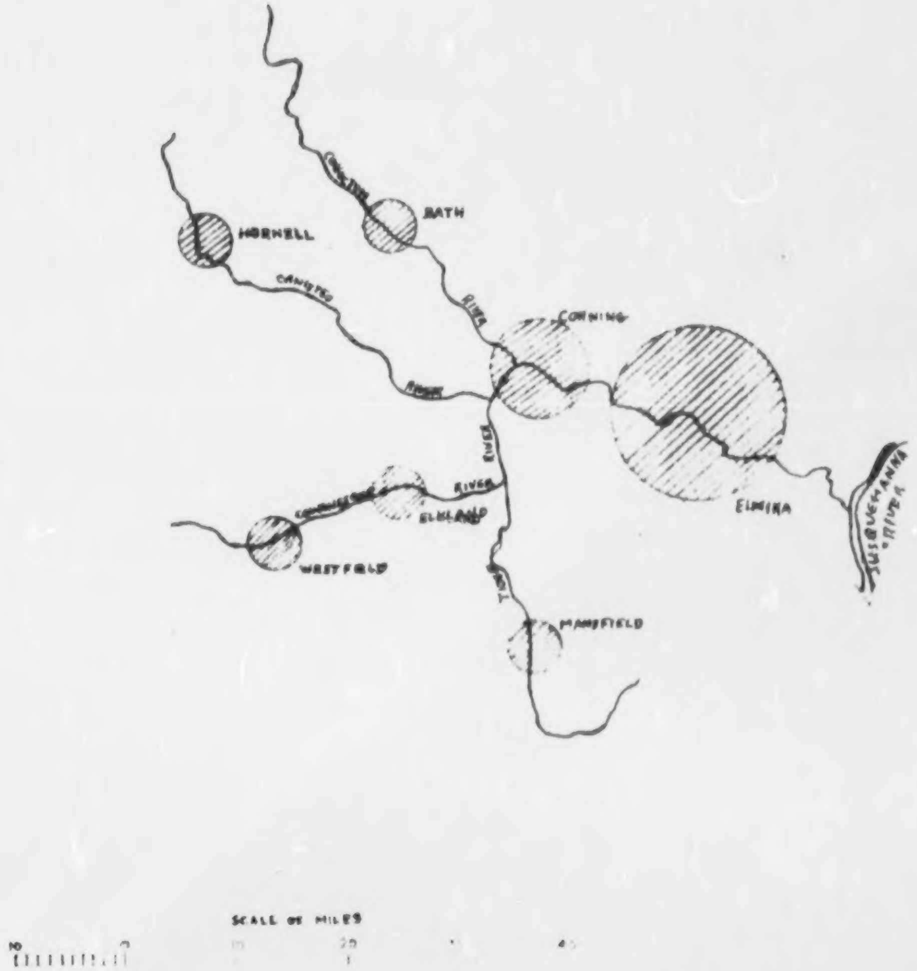
It is estimated that 400,000 fishermen-days are expended annually in this sub-basin. Trout streams amount to about 200 miles, while warm water fisheries per year total 1340 acres. It is estimated that 38,000 fishermen-days are spent on trout waters. Economically, the fishermen represent about 1.8 million dollars per year invested in the sub-basin on supplies, transportation, etc. By the year 2020, there will be 2.02 million user-days per year and 9.9 million dollars per year spent on fishing.

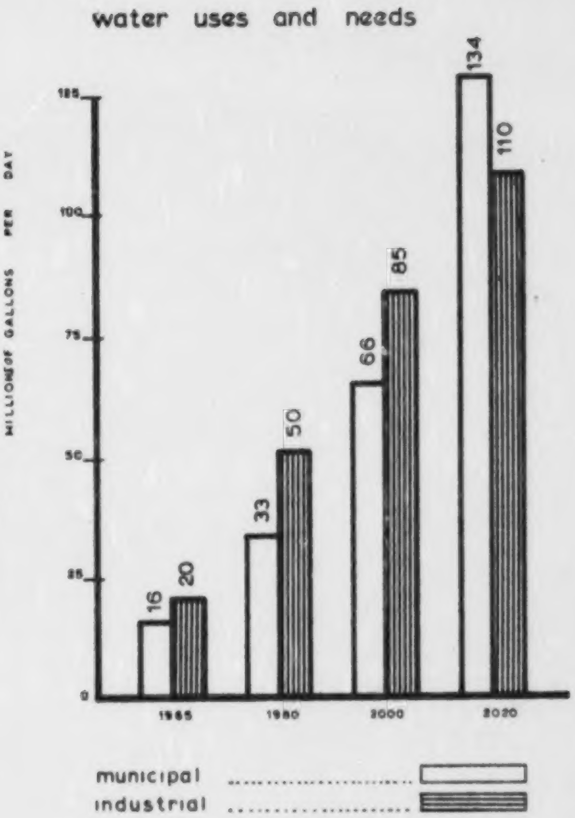
Year	Fishermen (1000's)	Fisherman Days/Year (Millions)	Annual Expenditures ($ Millions)
1980	40.1	0.77	3.4
2000	70.5	1.37	6.1
2020	112.2	2.02	9.9

Municipal and Industrial Uses

Public water needs are met by seven principal water service areas serving about 134,000 people with 36 million gallons of water per day. There is only one diversion of water out of the Chemung sub-basin from the Mud Creek watershed. The diverted water eventually flows into Keuka

CHEMUNG RIVER
WATER SERVICE AREAS





water uses and needs

Lake in the Lake Ontario drainage basin, but the diversion is not considered to be a significant loss because of the size and intermittent nature of withdrawal. If this diversion is developed as a full-time water supply system in the future, its impact in relation to the total water resource needs of the Chemung sub-basin will have to be re-evaluated.

Large amounts of ground water are used by the cities of Bath, Corning, and Elmira for public supplies. Elmira, however, gets most of its water from surface supplies. The Tioga-Hammond and the Cowanesque Reservoir Projects are potential water supplies for Elmira. Hornell also uses mainly surface supplies. Current resources are adequate to meet anticipated demands in all water service areas except Elmira. By 1980, this city will have to turn to ground or further developed surface water resources to meet these needs.

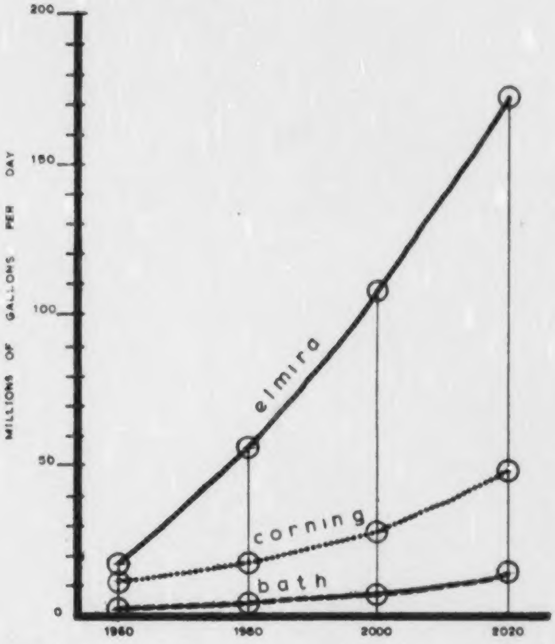
Future Water Needs

Year	Pop. Served (1000's)	Municipal (mgd)	Industrial (mgd)	Total (mgd)
1965	134.1	16.1	20.2	36.3
1980	234.0	32.8	50.3	83.1
2000	402.4	66.1	85.0	151.1
2020	712.8	134.1	110.4	244.5

Irrigation Uses

Irrigation will be significant in the Chemung sub-basin below Elmira where there is a potential water depletion problem to consider. This results from anticipated competition for water between irrigation demands and flow needs for water quality. Irrigation is a consumptive use of water and with reduced flow in the lower Chemung, Corning and Elmira may have to consider higher degree of treatment to compensate for flow reductions.

projected water needs at bath, corning, and elmira



An alternative would be to increase summer flows by augmentation. The source of irrigation water is anticipated to be primarily surface supplies, although considerable acreage is expected to be irrigated from ground water. The Department of Agriculture has estimated needs for irrigation uses of surface waters that may occur during drought years through 2020.

Year	Est. Acres Irrigated	Water Consumption (Acre Ft.)	Est. Max. Instantaneous Demand (cfs)
1965	400	600	5.0
1980	2000	2980	24.0
2000	3460	5200	42.0
2020	3960	5950	48.0

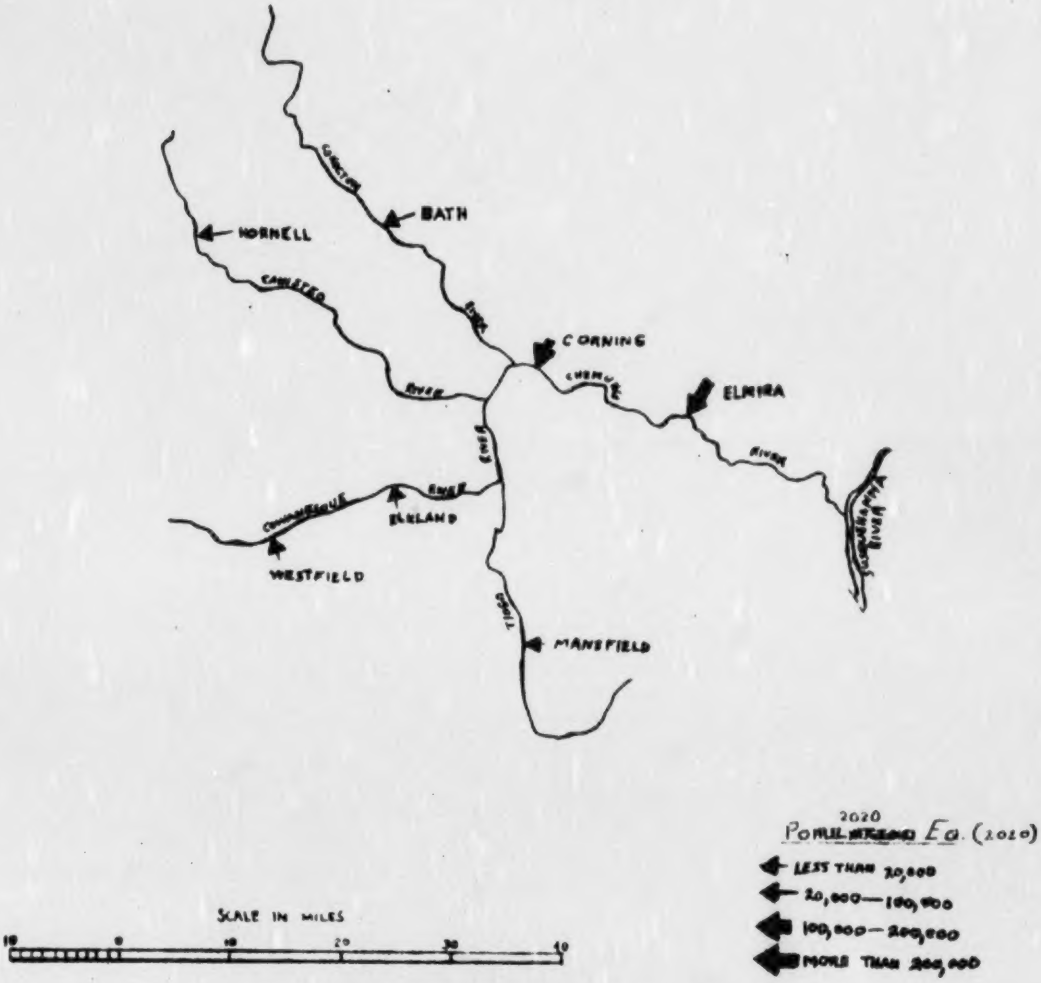
Cooling Water Uses

Electric power generation in this sub-basin has an installed capacity of 70 MW at the Hickling Station (New York Gas and Electric Company) near Corning, New York. It is presently expected to be phased out by 1990. An estimated 43.2 cfs of water is needed for condenser cooling.

Chemung

SOURCES, PROBLEMS,
AND
POLLUTION ABATEMENT

CHEMUNG RIVER
WASTE DISCHARGES



Sources of pollution were evaluated and the associated problems resulting from these discharge sources have resulted in specific pollution abatement actions necessary. The table below summarizes the current conditions in the sewage service areas and identifies immediate pollution control needs.

Sewage Service Areas and Immediate Needs Summary [1]

Sewage Service Area	Present Capacity (mgd)	Present Treatment Level	Immediate Treatment Level Needs (Dec. 1968)	Max. Allowable BOD Discharge (lb/day)
Mansfield, Pa.	---	None	Secondary	380
Westfield, Pa. (incl. Eberle Tannery)	0.2	Primary	Secondary	90
Elkland, Pa. (incl. Elkland Tannery)	0.2	Secondary	Increase capacity Secondary	280
Hornell	3.2	Primary	Advanced*	550
Bath	0.2	Primary	Secondary	1700
Corning	1.7	Primary	Secondary	5300
Elmira	9.3	Secondary	Increase capacity Secondary	16000

---

* BOD removal higher than secondary treatment.

[1] For nutrient removal needs, see section on Miscellaneous Problems.

The following sections present an evaluation of sources, problems, and the necessary pollution abatement actions. These are required to maintain water quality based on the anticipated growth and development of the Chemung sub-basin.

SOURCES AND PROBLEMS

Municipal and Industrial Wastes

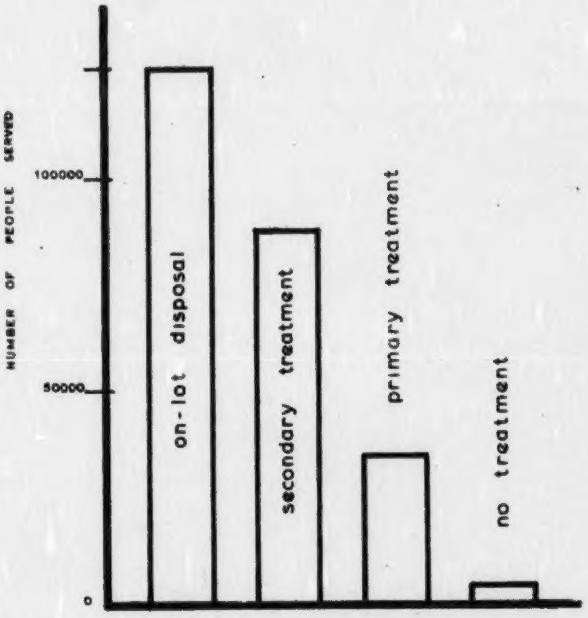
There are about 125,000 people served by collection systems. Primary treatment facilities serve about 34,000 people, while 88,000 people are presently provided with secondary treatment facilities. Collection systems serving 3,000 people in the Mansfield area discharge raw sewage into the Tioga. The remaining 125,000 residents of the sub-basin utilize on-lot disposal systems such as septic tanks. The population equivalence of waste loading is 265,000 before treatment, including all industrial wastes. After treatment, the total waste load discharged is equivalent to the raw waste from a population of 76,000.

Industrial waste loadings in the sub-basin include dairies, tanneries, and food processors. The largest single source of organic loading is the Ann Page Food Processing Plant in Horseheads, New York, which discharges its wastes to the secondary treatment facility operated by the Chemung County Sewer Authority. The Polio Fiorlat Dairy discharges its wastes without treatment to the Cohocton River. Plans are being made to connect this major source of pollution with the sewer system of either Erwins or Painted Post in New York. The Eberle Tannery in Westfield, Pennsylvania, and the Elkland Tannery in Elkland, Pennsylvania, contribute to pollution of the Cowanesque. The Eberle plant lagoons its wastes and attains the equivalent of 35 percent BOD reduction prior to discharge to the river. The Elkland plant provides primary and secondary settling, with BOD removal in the range of 50 to 70 percent. This represents 1250 to 1750 pounds of BOD discharged per day, after treatment.

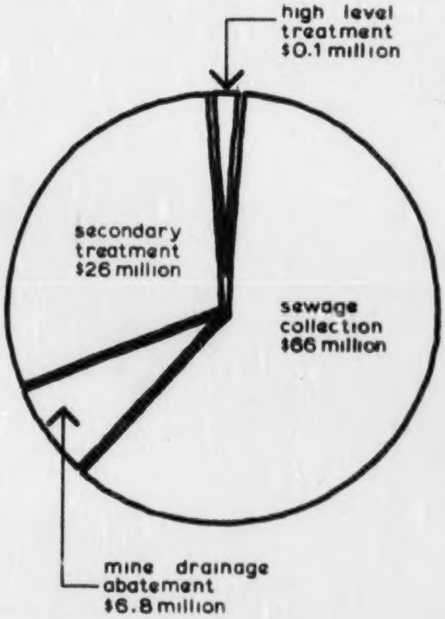
The Corning Glass Works constitutes a potential threat to a desirable ecosystem because of the use of hydrofluoric acid in some of its processes. In the past, the intermittent discharge of acid has caused adverse changes in pH from the acidic ion and inhibition of aquatid life due to the highly toxic fluoride ion. This plant, however, has an effective sanitary waste treatment facility and therefore causes no BOD loading.

Altogether the population equivalents attributable to all industrial activities in the sub-basin total 149,000 before treatment. This is reduced by present levels of treatment to 37,000 population equivalents.

breakdown of treatment methods
(1968)



costs of recommended abatement measures 1965-1980



ABATEMENT

Municipal and Industrial Wastes

To meet water quality management objectives, new or expanded collection and treatment facilities are necessary in all seven sewage service areas. Each area should provide a minimum of secondary treatment. Only two of the sewage service areas presently provide secondary treatment or its equivalent: Elkland, Pennsylvania, and Elmira, New York. Both of these plants are overloaded and need to expand their treatment capacity. Mansfield, Pennsylvania, has no treatment facility at present but is progressing with plans to install secondary facilities to be completed by early 1970. The communities of Westfield, Pennsylvania; Hornell, Bath, and Corning, New York, presently have only primary treatment capacities.

In the future, three critical stream reaches in the Canisteo and the Chemung Rivers will encounter waste assimilation difficulties; and the responsible municipalities, Hornell, Corning, and Elmira, will require high level BOD removal to achieve water quality standards objectives. In the case of Corning and Elmira, flow augmentation is an alternative.

The streams would be unable to maintain the specified 5.0 mg/l dissolved oxygen levels in spite of upstream treatment achieving 85 percent BOD removal. Hornell should install facilities immediately to **achieve a higher degree of treatment.** Facilities at all sewage service areas should provide for handling industrial wastes, where feasible. Industries not so served should provide the equivalent of secondary waste treatment.

Studies have been made on the seven sewage service areas to determine the future level of BOD reduction necessary to meet the objectives stated in the water quality standards. Secondary treatment will be required in all seven sewage service areas by 1980, to serve a population of 248,000 people. Capital expenditures for treatment will reach 26 million dollars; and for the year 2020, when 652,000 people will be served, 23 million dollars will be required for new facilities. None of these costs includes estimated average annual expenses for operation and maintenance, amortization of capital, etc.

Cost and Efficiency of Recommended Treatment

Time Period	1000's Population Equivalents		Estimated Capital Needs (Millions)	Estimated Average Annual Exp.	
	Received	Discharged		O & M (1000's)	Total (1000's)
1965-1980	274	76	26	411	2350
1980-2000	806	102	23	685	2690
2000-2020	1247	129	19	1088	3830

The capital costs of collection facilities will total 286 million dollars for the period 1965-2020; and the total population that is to be served by these facilities will be 652,000, based on figures for the ultimate needs of the year 2020.

Sewage Collection Facilities

Time Period	New Population Served (1000's)	Total Population Served	Estimated Cost (Millions)
1965	---	125	---
1965-1980	123.0	248	66
1980-2000	146.0	394	80
2000-2020	258.0	652	140

The table below summarizes the total costs of recommended treatment facilities including high level BOD removal. Costs do not include collection facilities.

Total Cost of Recommended Treatment Facilities *

Time Period	Population Equivalents (1000's) Received	Population Equivalents (1000's) Discharged	Estimated Capital Needs ($ Millions)
1965-1980	457	67	26
1980-2000	806	102	24
2000-2020	1247	129	23

* Costs do not include nutrient removal.

SOURCES AND PROBLEMS

Mine Drainage

Mine drainage is a problem arising from past as well as present mining operations, but is not generally a problem throughout the sub-basin. The only area mined for coal is located in the headwaters of the Tioga. The Tioga is degraded from Blossburg, Pennsylvania, to the New York-Pennsylvania State Line where it joins Crooked Creek. It is intermittently degraded from there to its point of confluence with the Canisteo River in New York.

Three watersheds are the sources of mine drainage: Morris Run, Coal Creek, and Bear Creek; all of these flow into the Tioga River, bringing an average flow of 10.5 mgd of acid laden waters with more than 60,000 pounds per day of acid and more than 7200 pounds per day of iron.

ABATEMENT

Mine Drainage

The importance of mine drainage abatement in the Tioga watershed is underscored by the fact that it has been ranked first priority by the Mine Drainage Work Group of the interagency effort on the Susquehanna (see priority list in Waste Sources, Problems and Pollution Abatement in the front section of this report). The most apparent feasible solution for control of pollution associated with mining activities includes a combination of physical preventive measures followed by chemical treatment of the acid discharges. Preventive measures include reconstruction of stream channels, excavation and restoration of subsidence areas, covering of refuse material, backfilling of selected strip mine areas, and the construction of surface water diversions at selected locations. Chemical treatment through lime neutralization is considered to be the most feasible means of removing the remaining acid loads being discharged to the streams of this area.

Treatment measures are usually considered supplemental to initial preventive measures and are designed to take care of the excess flow of acid during periods of heavy rainfall. Treatment facilities were designed on the basis of the once-in-ten-years expected heavy rainfalls. Lime neutralization was used for estimating treatment costs because it is the least expensive of methods presently operational. It is estimated that 6.77 million dollars will be the total capital expenditure needed, of which 3.75 million dollars would go for preventive measures.

MISCELLANEOUS WATER QUALITY PROBLEMS

SOURCES AND PROBLEMS

Nutrients

Nutrient loadings are a factor affecting water quality in this sub-basin bringing on summer algal blooms which are a recurring problem in all of the streams below discharge points of the sewage service areas. Nutrients come to the river from combined sewer overflows as well as in waste loadings from the community collection and treatment facilities. Only about 20 percent of the sub-basin is used for agricultural purposes so nutrient from these activities is negligible.

Combined Sewers

Five streams suffer periodic degradation by the overflow from combined sewers. These streams are: the Tioga River from Mansfield, Pennsylvania; the Cowanesque River at Elkland, Pennsylvania; Canisteo River from Hornell, New York; the Chemung River from Corning and Elmira, New York.

Individual Waste Disposal Systems

There will be an increase in rural population in the Chemung sub-basin. By 1980, rural population using septic tank systems for waste disposal is expected to grow to 132,000; and by 2020 it will increase to 188,000.

Thermal Pollution

The Hickling Power Station just below Corning, New York, uses about 43 cfs of river flow for condenser cooling. This is about one-third of the Chemung River flow during low flow periods. Available information indicates that water quality standards for temperature are not being exceeded.

ABATEMENT

Nutrients

Although there is evidence that nutrients are causing minor water quality degradation below the sewage service areas in this sub-basin, no specific abatement action to remove nutrients from waste water discharges is recommended at this time. In the future, as waste loadings increase, nutrient removal will probably be needed at all seven sewage service areas. Study efforts should continue to determine the levels of phosphorus and nitrogen in the streams and to identify stream reaches where these nutrients may be the cause of water quality degradation.

Combined Sewers

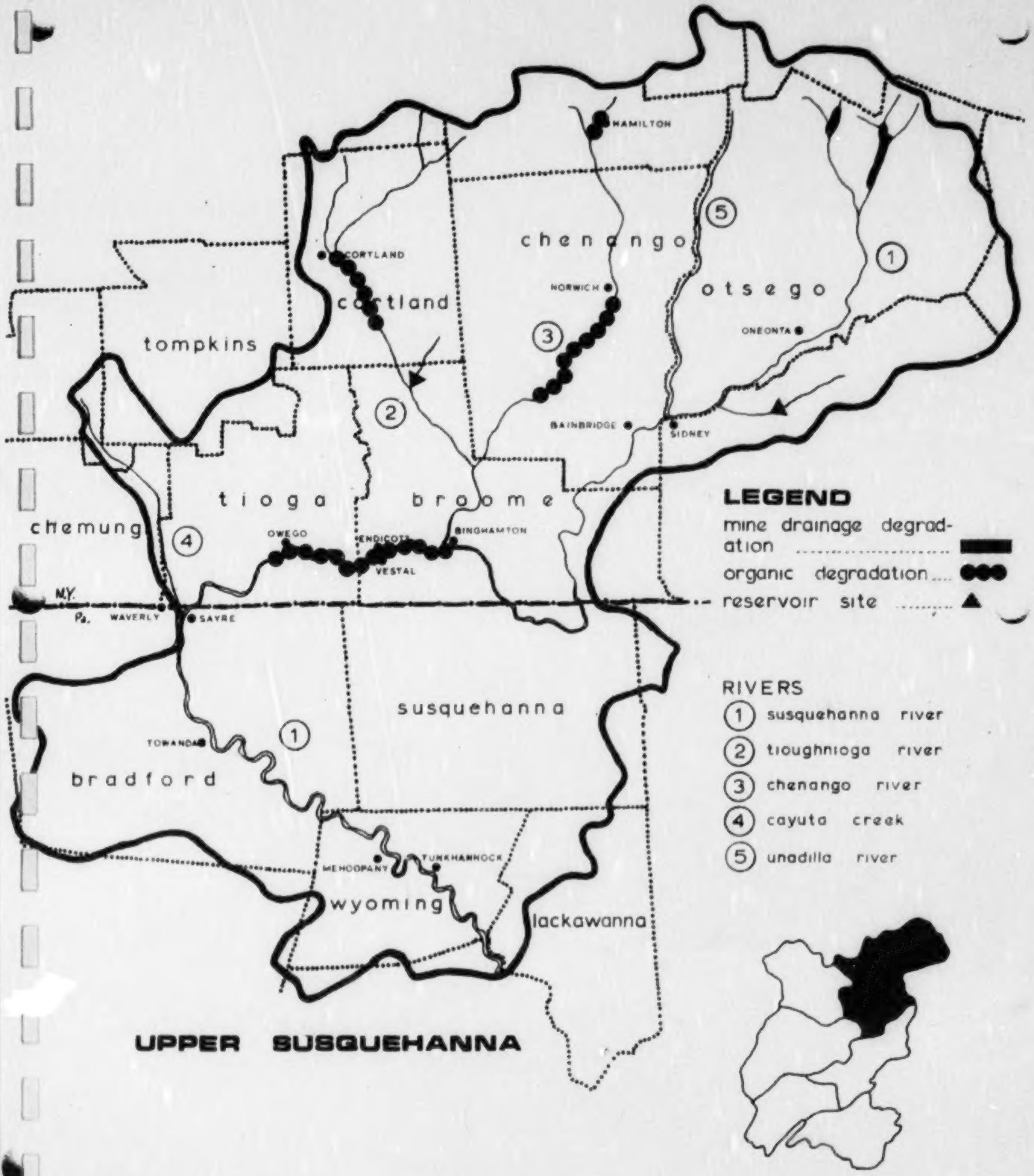
Numerous methods for the elimination of the adverse effect from combined sewers are currently under intense study, but at the present no economically feasible method is available for abating this type of pollution. Until a practical solution to the problem is found, it is assumed that existing combined sewers will continue to be used. It is recommended that no new combined sewers be built, and that no extensions of combined sewers be undertaken.

Individual Waste Disposal Systems

It may not be feasible for all rural populations to connect with regional collection facilities. Both New York and Pennsylvania administer laws regarding septic tank usage where tank capacity and drain field construction vary with soil type, lot size, and living-quarters capacity. These kinds of facilities can be very efficient when properly designed and maintained, but wherever possible, people are encouraged to connect into a regional collection system.

Thermal Pollution

Although the Hickling Power Station is scheduled to be phased out of operation by 1990, a forced cooling system may have to be installed to avoid future water quality problems resulting from thermal discharges. A thorough study is needed to determine the size and operation of any cooling system.



UPPER SUSQUEHANNA

General Description

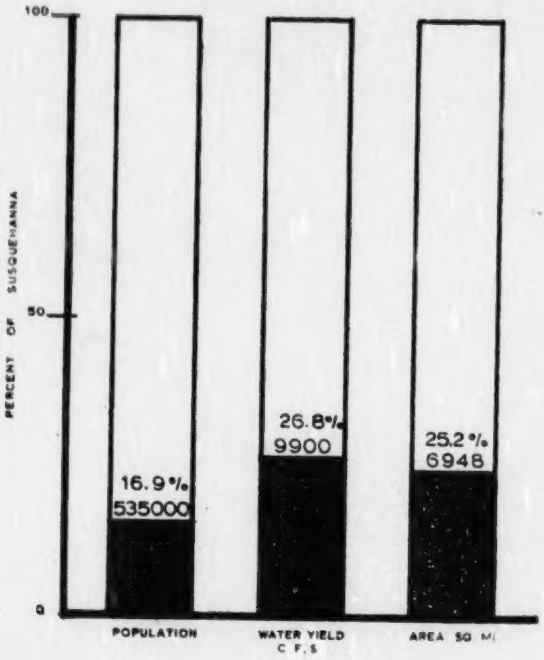
The Upper Susquehanna sub-basin is characterized by rolling, patternless hills, and fairly broad valleys. About 45 percent of the land is forested, with much of the rest used for grassland farming. The streams alternate between swift rapids and placid eddys and often have very low flows from July to November.

The population is centered around the Binghamton-Endicott metropolitan area of sourthern New York, a relatively prosperous section. The Pennsylvania portion of this sub-basin is primarily rural. In 1965 the total population of the sub-basin was 535,000, 17 percent of the total population for the basin, with about 275,000 people living in urban areas. By 2020, the population is expected to reach nearly 1.7 million.

For purposes of this study, the Upper Susquehanna was divided into ten water service areas to determine current municipal and industrial uses and to predict future concentrated demands on streams in the sub-basin. It was divided into 12 sewer service areas to determine current waste handling and sewage treatment practice and to predict future water quality needs.

There is no quality or quantity problem with the water in the Pennsylvania portion of the sub-basin. In the New York portion, however, there is severe degradation in the headwaters area below Hamilton and Cortland, and in the reach immediately below Binghamton. These places need high level BOD removal to meet water quality standards, or as an alternative, some low flow augmentation. In addition, eight other communities which now provide less than secondary treatment will require upgraded treatment facilities.

percent of total susquehanna basin



An understanding of the surface and ground water resources is basic to effective water quality management programs commensurate with both quantity and quality for the various water uses. The quality and quantity of surface and ground waters in the Upper Susquehanna sub-basin are adequate to meet current demands, and with proper development these resources will be capable of meeting future requirements through the year 2020.

Waste assimilative capacities of the streams of the sub-basin are a function of flow and temperature during the critical summer season from July through October. Major tributaries of the sub-basin, shown in the following table, exhibit wide fluctuations of stream flow and clearly indicate the effects of drought conditions during the summertime on dependable stream flow which must be considered in delineating water quality management programs for the water service areas of the sub-basin.

Stream Flow Characteristics at Selected Locations

Stream and Gauge*	Instantaneous Flow Extreme Max.	Instantaneous Flow Extreme Min.	Mean An. Flow	August Flow Data Mean Flow	August Flow Data 1-in-29-yr. Low Flow	August Flow Data Minimum Daily Flow
Susquehanna River at Unadilla, N.Y.	21,500	45	1,541	377	98	93.1
Chenango River at Greene, N.Y.	18,900	37	896	185	64	54.5
Tioughnioga River at Cortland, N.Y.	13,000	9.8	474	100	40.1	35
Susquehanna River at Vestal, N.Y.	92,400	230	6,176	1,368	370	341
Susquehanna River at Towanda, Pa.	191,000	334	10,340	3,050	700	571

* Data collected by U.S. Geological Survey
(all measurements stated in cfs)

Whitney Point Reservoir, Chenango Valley, Dryden Lake, Gilbert Lake, and Otsego Lake all impound good quality water. Canaderaga Lake, the second largest lake in the sub-basin, is badly infested with algae because of high nutrient loadings. The State of New York is presently carrying out a study to determine the sources os nutrients and corrective measures.

IMPOUNDMENTS

Lake or Park	County	Surface Area (Acres)	Quality Description
Whitney Point Reservoir	Broome	1200	Good
Chenango Valley	Broome	63	Good
Dryden Lake	Tompkins	100	Good
Gilbert Lake	Otsego	60	Good
Otsego Lake	Otsego	3000	Good
Canaderaga Lake	Otsego	2000	Nutrient Pollution

Economic Base

The counties comprising the Upper Susquehanna economic subregion are Broome, Chenango, Cortland, Delaware, Otsego, and Tioga in New York and Bradford, Susquehanna and Wyoming in Pennsylvania. In 1960, these counties represented only about 15 percent of the Susquehanna Basin's population; only Broome County is heavily populated, with about 300 people per square mile. The population of the subregion is projected to increase more than 65 percent from 1960 to 1990, exceeding the rates of both the nation and the basin as a whole.

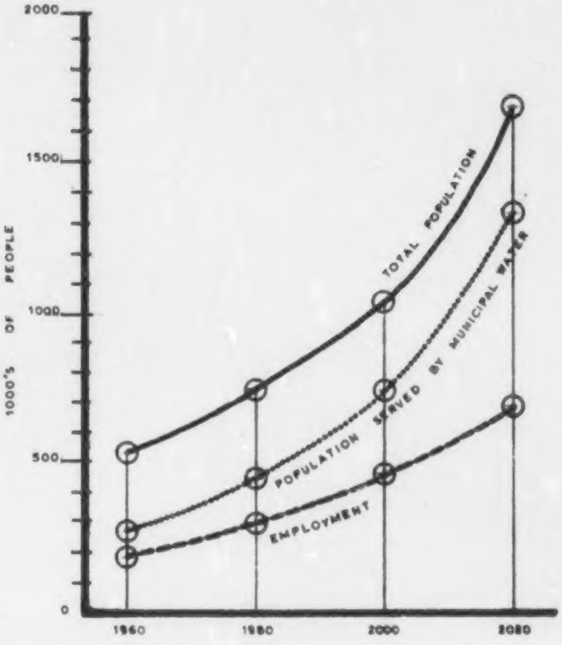
Manufacturing employment will increase rapidly but will be overshadowed by increases in the nonmanufacturing sector. In 1960, manufacturing accounted for 37 percent of total employment in this area, compared with 26 percent for the nation.

The industries projected to grow rapidly are ordnance, transportation equipment, paper and pulp, printing and publishing, and electrical equipment. The electrical machinery industry is projected to experience brisk growth during the 1960-1990 interval due to an influx of industry coming to the area in response to three attractions: (1) proximity to the northeast metropolitan complex; (2) local customers, e.g., IBM; and (3) the abundant labor supply.

Employment in non-electrical equipment was the second most important source of employment in this area. In 1960, several large producers of computers, business machines, and typewriters were located here; however, employment in this industry will grow slowly through 1990.

While the chemical industry is expected to experience moderate growth in employment, the consumer-oriented pharmaceutical, cosmetic, and perfume sectors are expected to experience fairly rapid growth. Pulp and paper

population and employment trends



will more than triple in employment over the 1960-1990 period and will account for about 3.5 percent of total manufacturing employment in 1990.

In 1960, the most important source of total manufacturing employment was the leather and leather products industry which accounted for more than 20 percent. It is expected to drop significantly, however, through 1990, primarily because of a drop in the shoe industry; rising labor costs, reduced dependence on skilled labor, and reduced capital requirements have caused the shoe industry to become more footloose, geographically.

Nonmanufacturing employment is expected to increase by about 360 percent between 1960 and 1990. This exceeds the projected growth of the Susquehanna Basin as a whole as well as that for the nation.

Chenango, Cortland, and Otsego Counties are among the nation's leading dairying counties; however, employment will decline from about ten percent in 1960 to less than three percent in 2020.

Mining is unimportant and is restricted to sand and gravel used for local construction.

Rapid growth in transportation, wholesale trade, finance, and government is expected, although they will continue to represent a low share of total employment. In addition, the share for services will increase to about 30 percent in 1990 and to about 50 percent in 2020.

The per capita income in 1960 dollars is projected to grow from 2000 dollars in 1960 to 5000 dollars in 1990 and to 10,700 in 2020. This level exceeds that for the basin as a whole as well as the nation.

Employment in the major water using industries is projected to expand by 1990; only textile employment is expected to contract to any significant degree. Stable or growing employment levels coupled with increases in output per employee are expected to result in the growth of total output.

The following table gives the percent change in total output from 1960 to 1990 for the large water using industries.

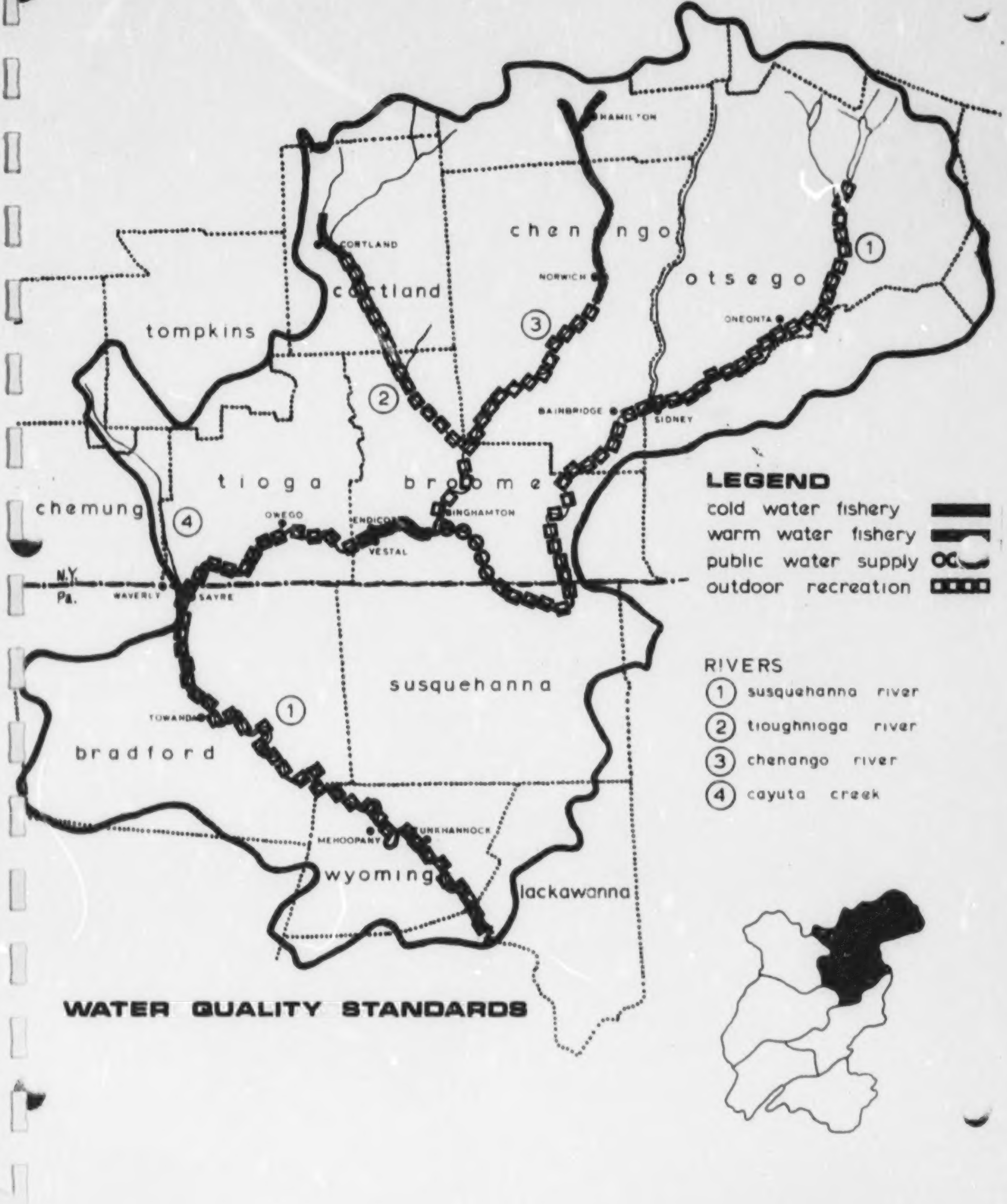
Projected Growth in Output for Major Water Using Industries
(in percent)

	1960 to 1970	1960 to 1980	1960 to 1990
Food	54	112	181
Textiles	- 35	- 76	-100
Paper	276	723	888
Chemicals	87	215	375
Primary Metals	42	86	147

Population and industrial growth projections as summarized above were used to project future waste loadings for the Upper Susquehanna sub-basin.

WATER QUALITY MANAGEMENT OBJECTIVES:

Present and Future Water Uses



WATER QUALITY STANDARDS

Water Quality Standards

Standards for the interstate streams in the Upper Susquehanna sub-basin have been adopted by the statees of New York and Pennsylvania and have been approved by the Department of the Interior.

In this sub-basin there are two reaches designated for public water supply and associated uses: the Susquehanna above Binghamton and Oneonta. There are, however, 12 reaches designated to be used for bathing, recreational, and other such uses. Aquatic life is the designated use in seven reaches, with two reserved exclusively for cold water fishing. Two of the reaches designated for bathing and associated uses are also designated for use as cold water fisheries.

On unclassified intrastate streams, water quality standards will be similar to the interstate standards. The minimum dissolved oxygen objective will be 5.0 mg/1, and the temperature will not exceed a maximum of 84 F or a maximum increase of 5 F at the end of a mixing zone.

Recreation Uses

Recreation waters of the sub-basin are currently used at a rate of three million recreation user-days per year and one million boating days a year. There are about 600,000 people in the recreation population market, which is about 100,000 in excess of the actual population in residence. Out of the 12,720 acres of streams and 16,200 of lakes in the sub-basin, about 3160 acres is considered available to the public for recreation.

Projected Recreation Uses

Target Year	Rec. Market Area Pop. (1000's)	Demand Million Days/Yr. Rec.	Demand Million Days/Yr. Boating	Supply Million Days/Yr. Rec.	Supply Million Days/Yr. Boating	Deficit Million Water-Oriented Rec. Days/Yr.
1980	737	7.51	1.34	5.30	1.29	2.21
2000	1114	14.79	2.31	6.78	1.63	8.01
2020	1800	23.90	3.61	7.23	2.05	16.67

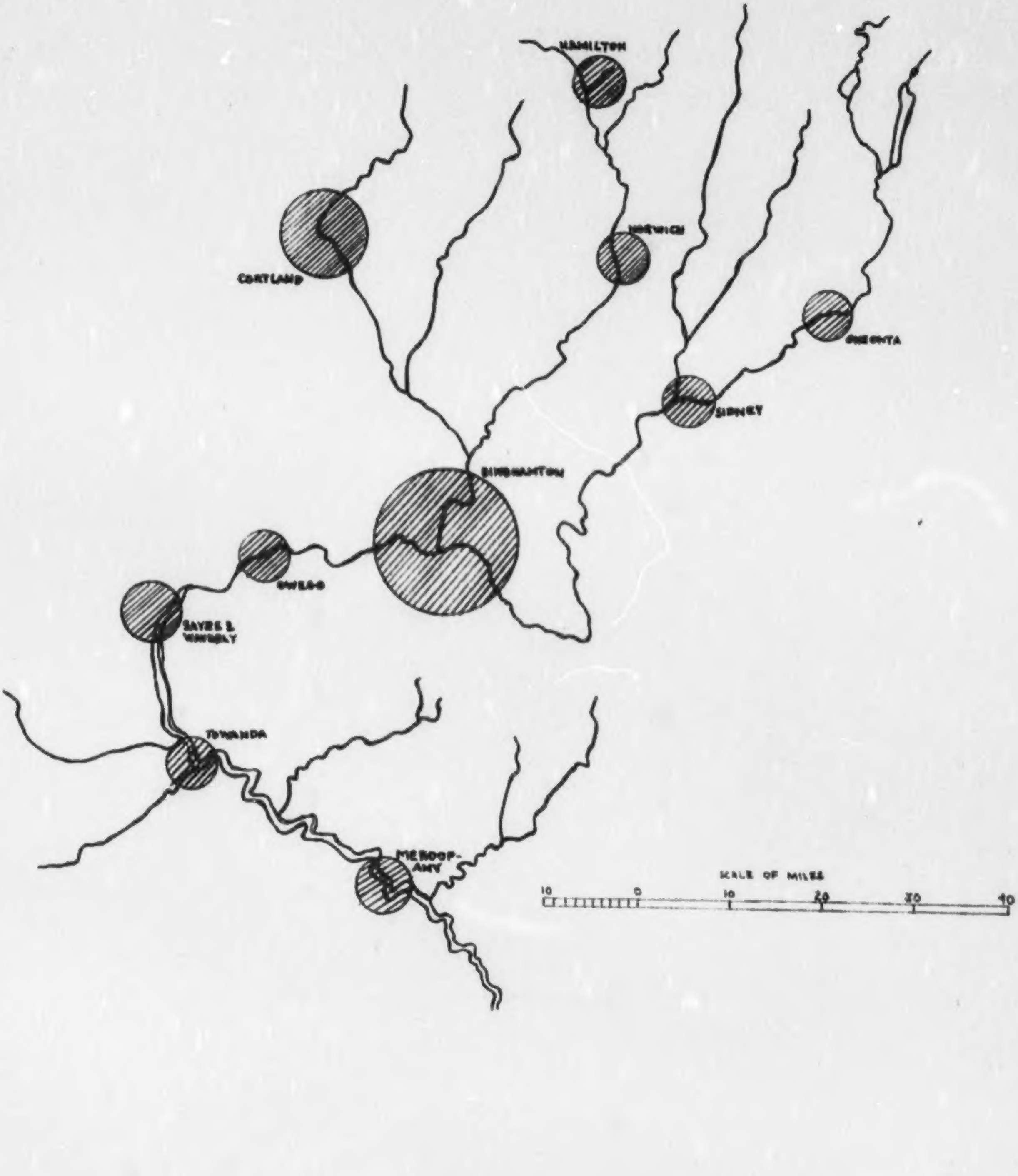
There are 53,100 fishermen who use the waters of this sub-basin each year, including both residents and out-of-state people. They spend an estimated 4.5 million dollars on goods and services per year during the one million fishermen-days expended annually. Much of the demand is placed on cold water fisheries, with about 355,000 user-days spent on trout streams. There are 1342 miles of trout streams and 458 miles of warm water fisheries used at present.

Year	Fishermen (1000's)	Fisherman Days/Yr. Millions	Annual Expenditures ($ Million)
1980	87.0	1.57	7.4
2000	142.0	2.75	12.2
2020	211.9	3.81	18.6

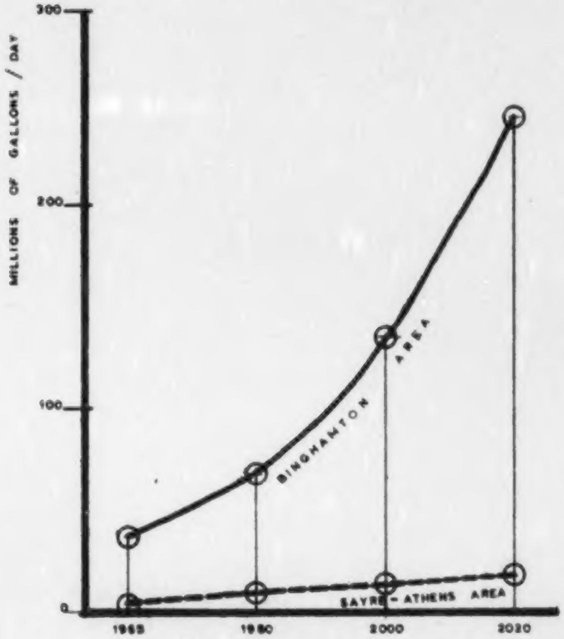
Municipal and Industrial Uses

Municipal and industrial demands are met largely by ten principal water service areas. They serve 275,000 people with about 67 million gallons of water daily. Approximately 50 percent of this comes from ground sources and the rest from surface sources. There is only one out-of-basin diversion, but it is considered to be insignificant. Water is diverted from the West Branch of the Tioughnioga River to the New York canal system during spring months.

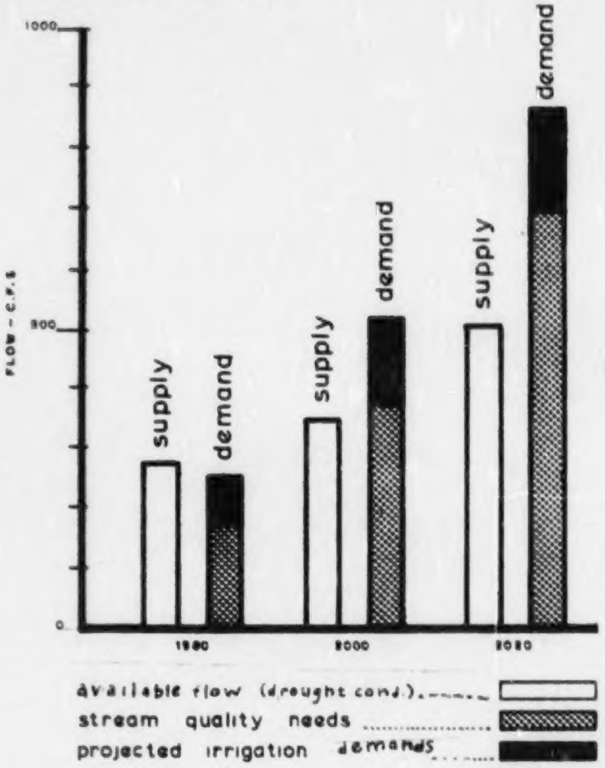
UPPER SUSQUEHANNA
WATER SERVICE AREAS



projected water needs at binghamton & sayre - athens



projected competition for stream flow below binghamton, n.y.



The Susquehanna River itself supplies water for the cities of Binghamton, New York and Sayre and Athens, Pennsylvania. The Charmin Paper Company near Mehoopany, Pennsylvania also uses the Susquehanna as a source of water. Total water requirements are expected to increase: by the year 2020, municipal needs will increase about eight fold, but industrial demands will be at least ten times greater.

Irrigation Uses

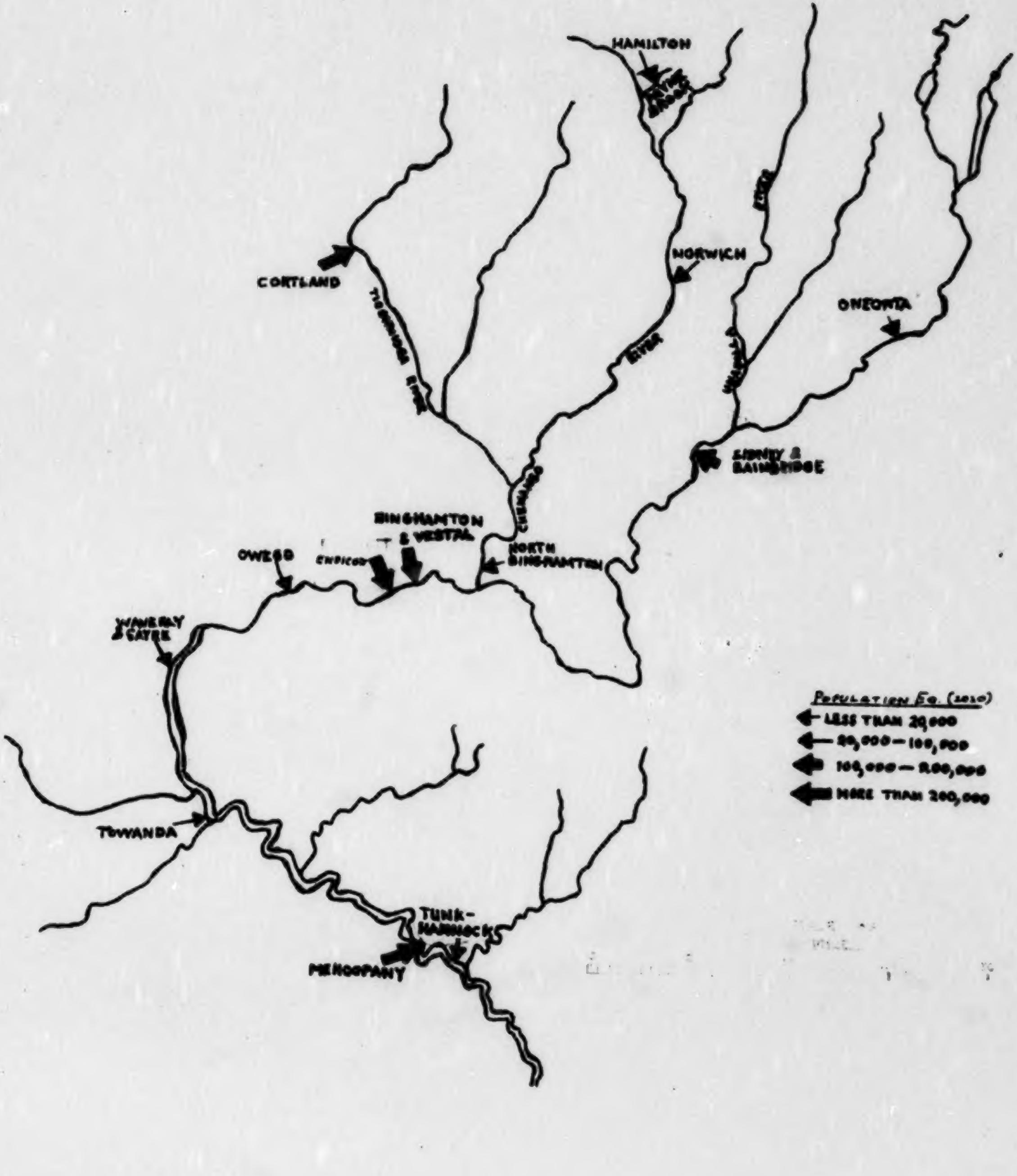
Irrigation is significant in the Upper Susquehanna sub-basin only because of its water depletion potential above Binghamton. Water for this use is expected to come from both ground and surface water supplies. The Department of Agriculture has projected the amounts of water to be used for irrigation out of streamflows during drought years. Unless watershed developments compensate for predicted withdrawals, the losses to irrigation will be detrimental to water quality flow needs below Binghamton.

Cooling Water Uses

Electric power is generated by three plants in this sub-basin. Two of these plants are conventional steam plants, while the other is a small hydroelectric facility near the town of Susquehanna, Pennsylvania and is being phased out at the present time. Two of the plants use water from the Susquehanna in a once-through cooling system. At the present time a study is being conducted by the Pennsylvania Electric Company on the feasibility of locating a large atomic facility near Towanda.

SOURCES, PROBLEMS,
AND
POLLUTION ABATEMENT

UPPER SUSQUEHANNA WASTE DISCHARGES



Sources of pollution were evaluated and the associated problems resulting from these discharges have resulted in specific pollution abatement actions necessary. The table below summarizes the current conditions in the sewer service areas and identifies immediate pollution control needs.

SEWAGE SERVICE AREAS AND IMMEDIATE NEEDS SUMMARY

Sewage Service Area	Present Capacity (mgd)	Present Treatment Level	Immediate Treatment Level Needs (Jan. 1969)	Max. Allowable BOD Discharge
Oneonta, N.Y.	1.7	Primary	Secondary	2000
Sidney, N.Y.	0.5	Primary	Secondary	4300
Hamilton, N.Y.	0.4	Intermediate	Secondary	690
Norwich, N.Y.	1.0	Intermediate	Secondary	1800
Cortland, N.Y.	6.0	Primary	Secondary	6000
Binghamton, N.Y. North Plant	---	None	Secondary	2500
Binghamton, N.Y. River Plant	10.8	Primary	Secondary	13500
Endicott				
Vestal, N.Y.	1.0	Primary	Secondary	500
Endicott, N.Y.	9.9	Primary	Secondary	4600
Owego, N.Y.	1.6	Primary	Secondary	4200
Waverly-Sayre				
Waverly, N.Y.	---	None	Secondary	2000
Sayre, Pa.	2.0	Primary	Secondary	2000
Towanda, Pa.	0.5	Primary	Secondary	15000
Mehoopany, Pa.	11.6	Secondary		20000

The following sections present an evaluation of sources, problems, and the necessary pollution abatement actions required to maintain water quality in keeping with the anticipated growth and development of the Upper Susquehanna sub-basin.

SOURCES AND PROBLEMS

Municipal and Industrial Wastes

Less than half the total population, about 222,000 people, are served by sanitary sewage collection systems. About 9,000 of these people are connected to systems that discharge directly to receiving streams without treatment. Another 210,000 use collection systems that discharge to the receiving stream after primary treatment, and only 3,000 have collection systems connected with secondary treatment facilities. The remaining residents, about 280,000, utilize on-lot disposal systems. The population equivalent loading, for the sub-basin, including industrial wastes, is 303,000. After treatment, a waste load is discharged which is equivalent to the raw waste from a population of 197,000.

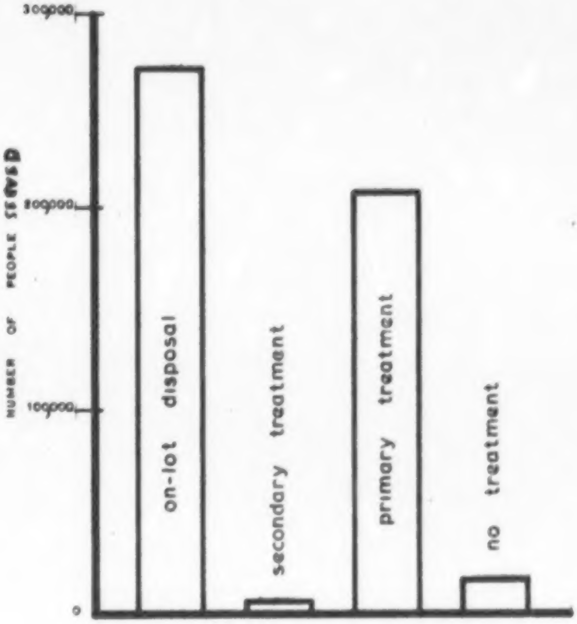
The heaviest concentration of discharges occurs in the Binghamton-Endicott area of New York where less than primary treatment is generally provided. These wastes cause degradation of the Susquehanna between Endicott and Owego.

Industries produce the population equivalence of 59,430 before treatment. About 40,000 population equivalents are discharged after treatment.

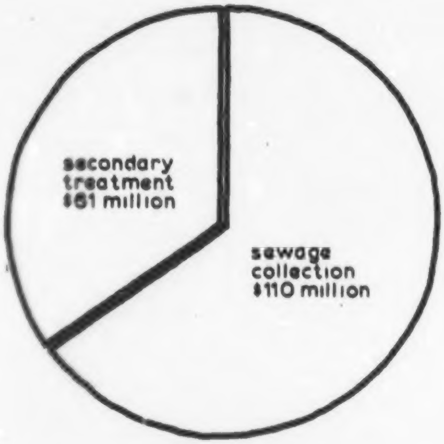
The Norwich Pharmaceutical Company, which manufactures drugs for human and veterinary use, constitutes the major polluter among the industrial firms of the sub-basin.

Two meat packing operations, the Camp Packing Company in Cortland the Speciality Foods in Johnson City, contribute minor pollution loads in their areas.

breakdown of treatment methods
(1968)



costs of recommended abatement measures 1965 - 1980



ABATEMENT

Municipal and Industrial Wastes

All waste treatment facilities should achieve and maintain at least secondary treatment.

Projected Capital Needs for Secondary Treatment of Wastes

Time Period	1000's Population Served: Population	1000's Population Served: Population Equivalent	Est. Capital Needs ($ Millions)
1965-1980	430	110	61
1980-2020	1290	2540	80

To meet the approved and adopted water quality standards for critical stream reaches, a mix of flow regulation and high level waste treatment will be required for the Binghamton, Cortland, and Hamilton areas. The Charmin Paper Company at Mehoopany has already provided secondary treatment, but this is inadequate for protection of the high quality water in this reach of the Susquehanna.

By 2020, it is expected that nealy 1.3 million people will be receiving sewage service. The costs of extended collection systems and installing secondary treatment facilities are presented below.

Projected Extension of Sanitary Collections

Time Period	Total Pop. Served (1000's)	New. Pop. Served (1000's)	Est. Capital Needs ($ Millions)
1965	222		
1965-1980	430	208	110
1980-2000	726	296	160
2000-2020	1290	564	306

Potential multi-purpose reservoir sites have been located upstream from Cortland and Binghamton whose use for flow augmentation appears to be justified. Use of these reservoirs is recommended as a partial means of achieving water quality objectives.

Presented below are the costs of achieving water quality objectives based on treatment alone. The costs include high level BOD removal but do not include the cost of collection facilities.

Total Costs of Recommended Treatment *

Time Period	Population Equivalents (1000's) Received	Population Equivalents (1000's) Discharged	Estimated Capital Needs ($ Millions)
1965-1980	1110	166	61.1
1980-2000	1660	213	82.0
2000-2020	2540	306	6.5

* Costs do not include nutrient removal.

VII-13.a

MISCELLANEOUS WATER

QUALITY PROBLEMS

SOURCES AND PROBLEMS

Nutrients

Nutrient enrichment occurs downstream from four sewage service areas in this sub-basin. Four stream reaches are affected by excessive algae and weeds. These are the Tioughnioga River below Cortland, the Chenango River below Norwich, the Susquehanna River below Endicott, and Payne Brook below Hamilton. The effluent from treatment plants in the areas is suspected to be the cause of the nutrient enrichment. Nutrients from agricultural and feedlot runoff is not significant in this sub-basin.

Combined Sewers

Combined sewers exist in six communities in the sub-basin. They are at Sayre, Pennsylvania, and at Binghamton, Endicott, Cortland, Sidney, and Owego, New York. Although the discharges from these sewers periodically degrade the receiving streams, the extent of organic and nutrient loadings coming from these combined systems has not been evaluated.

Individual Waste Disposal Systems

There are presently 278,000 people using on-lot waste disposal. In 1980, this figure will probably drop to 220,000 as suburban housing developments are extended sanitary waste collection service. However, rural residences are projected to increase to 310,000 by 2020.

Thermal Pollution

Currently, heated water is being discharged from two power plants in the Upper Susquehanna sub-basin. They are the New York Gas and Electric's Jannison Station near Bainbridge and the Goudy Station at

Johnson City. The Jennison Station uses about 51 cfs of flow for condenser cooling while the Goudy Station uses 70 cfs. Although the stations use one-fifth to one-fourth of the available flow during drought periods, they do not create a significant thermal pollution problem at present.

A potential source of thermal pollution for the future exists at Towonds where the Pennsylvania Electric Company is investigating the feasibility of locating a large atomic facility.

ABATEMENT

Nutrients

Although there is evidence that nutrients are causing water quality problems in this sub-basin, no specific abatement actions to remove nutrients from waste waters is recommended at this time. In the future, nitrate and phosphate removal will probably be required at Hamilton, Cortland, Norwich, and Binghamton-Endicott. Study efforts should be continued to determine the levels of phosphorus and nitrogen in the streams and to identify stream reaches where these nutrients may be the cause of water quality degradation.

Combined Sewers

Numerous methods of elimination of the adverse effects of combined sewer discharges are currently under intensive study, but at the present, no economically feasible method is available for abating the pollution from this source. Until a practical solution is found, it is assumed that existing combined sewers will continue to be used. It is recommended that no new combined sewers be built.

Individual Waste Disposal Systems

It may not be feasible for all rural populations to connect with regional collection facilities. Both New York and Pennsylvania administer laws regarding septic tank usage where tank capacity and drain field construction vary with soil type, lot size, and living-quarters capacity. These kinds of facilities can be very efficient when properly designed and maintained, but wherever possible, people are encouraged to connect into a regional collection system.

Thermal Pollution

The possibility of thermal pollution arising from the tentative plant at Towonda, Pennsylvania requires careful study. If the Pennsylvania Electric Company finds the atomic power station to be feasible then forced cooling will have to be installed to meet Pennsylvania stream standards on temperature and to avoid complicating the organic loads at Mehoopany.